EXHIBIT 42

GOVERNMENT OF PUERTO RICO
PUBLIC SERVICE REGULATORY BOARD
PUERTO RICO ENERGY BUREAU

IN RE: REVIEW OF THE PUERTO RICO ELECTRIC POWER AUTHORITY INTEGRATED RESOURCE PLAN	**CASE NO.:** CEPR-AP-2018-0001 **SUBJECT:** Final Resolution and Order on the Puerto Rico Electric Power Authority's Integrated Resource Plan.

FINAL RESOLUTION AND ORDER ON THE PUERTO RICO ELECTRIC POWER AUTHORITY'S INTEGRATED RESOURCE PLAN

CONTENTS

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

I. INTRODUCTION

1. On March 15, 2018, the Energy Bureau of the Puerto Rico Public Service Regulatory Board (Energy Bureau) issued a Resolution and Order commencing this proceeding and authorizing the Puerto Rico Electric Power Authority (PREPA) to file an updated Integrated Resource Plan (IRP) prior to the mandatory review established in Act 57-2014, in order to determine the impacts of Hurricanes Irma and María that devastated the Island.[1] This IRP filing is the second PREPA IRP proceeding and follows the previously approved IRP (the 2015 IRP), which included significant findings and directives with respect to PREPA's acquisition, retirement, and development of additional resources.[2] On February 13, 2019, PREPA filed its IRP along with supporting workpapers and other documentation in this proceeding. On March 14, 2019, the Energy Bureau issued a Resolution and Order in which it determined that the IRP filing was incomplete.[3] After a series of delays and extensions, on June 7, 2019, PREPA filed the IRP that is the subject of this proceeding (Proposed IRP).[4] On July 3, 2019, the Energy Bureau issued an Order setting forth the procedural schedule in accordance the Regulation 9021.[5] In this Final Resolution and Order, the Energy Bureau **APPROVES IN PART AND REJECTS IN PART** the Proposed IRP as shall be discussed in more detail in this Final Resolution and Order. The Energy Bureau **FURTHER MODIFIES** the Action Plan in the Proposed IRP submitted by PREPA and **ORDERS** the adoption and implementation of the Modified Action Plan as set forth in this Final Resolution and Order.

2. **Part I** summarizes the Energy Bureau's decisions on the features of PREPA's Proposed IRP and its compliance with our regulations. It describes the basics of integrated resource planning including: the Legislature's vision; the goals and requirements of integrated resource planning; the Energy Bureau's requirements; recent related

[1] Resolution and Order, In Re: Review of the Puerto Rico Electric Power Authority Integrated Resource Plan, Case No. CEPR-AP-2018-0001, March 15, 2018. In its Resolution and Order the Energy Bureau commenced the IRP review process and established the initial procedural calendar.

[2] Final Resolution and Order, In Re: Integrated Resource Plan for the Puerto Rico Electric Power Authority, Case No. CEPR-AP-2015-0002, September 23, 2016.

[3] Resolution and Order, In Re: Completeness of Puerto Rico Electric Power Authority Integrated Resource Plan Filing, Confidential Treatment of Portions of the Integrated Resource Plan and Requested Waivers, Case No. CEPR-AP-2018-0001, March 14, 2019.

[4] Puerto Rico Integrated Resource Plan 2018-2019, Draft for the Review of the Puerto Rico Energy Bureau, Prepared for the Puerto Rico Electric Power Authority, June 7, 2019.

[5] Resolution and Order, In Re: Completeness Determination of PREPA's IRP Filing and Procedural Calendar, Case No. CEPR-AP-2018-0001. July 3, 2019. The Energy Bureau noted the importance of proceeding with the IRP process and ordered PREPA to also file additional information, page 2.

legislation and regulations of the Energy Bureau; and events that have impacted the IRP. It then describes the process and participation in this proceeding by intervenors, *amici curiae*, and the public—who provided a meaningful contribution in this process.

3. **Part II** provides a summary and explanation of PREPA's approach to resource development plans, including the proposed MiniGrid approach and the modeling of scenarios, strategies, and sensitivities. This Part also sets forth an overview and context for the subjects that are covered in the next several Parts.

4. **Part III** discusses the following subjects in detail: **Part III(A)** - the load forecast; **Part III(B)** - energy efficiency (EE) and demand response (DR); **Part III(C)** - existing resource options along with their description and documentation; **Part III(D)** - the resource needs assessment; **Part III(E)** - new resource options on the supply side including distributed generation (DG) and utility-scale supply resources; **Part III(F)** - assumptions and forecasts; **Part III(G)** - resource plan development documentation and analysis; **Part III(H)** - caveats and limitations to the IRP; and **Part III(I)** – transmission and distribution (T&D) system analysis including consideration of MiniGrids and microgrids. For each of these Parts, we begin with a description of PREPA's IRP filing, followed by the position of the intervenors. These summaries are followed by the Energy Bureau's findings and a discussion setting forth the rationale for our conclusions.

5. **Part IV** addresses the elements of the approved Action Plan and provides a summary and explanation as to the Energy Bureau's modifications to the components of the Action Plan filed by PREPA.

6. **Part V** discusses the necessary preparations for the next IRP cycle.

7. **Part VI** contains our findings of fact and conclusions of law.

8. Thereafter, this Final Resolution and Order contains four appendices: **Appendix A** – Timeline and History of the Proceeding, **Appendix B** – Summary of Public Comments, **Appendix C** - Summary of Resource Development Scenarios, and **Appendix D** – Abbreviations.

A. Summary of Energy Bureau's Findings and Orders

9. The Energy Bureau makes findings with respect to PREPA's Proposed Preferred Resource Plan which forms the basis for PREPA's Action Plan; the components of PREPA's Proposed IRP; and, PREPA's Action plan as modified by the Energy Bureau. The Energy Bureau also **APPROVES** a Modified IRP and directs PREPA to take internal actions to help prepare for the next IRP.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

1. Determinations by the Energy Bureau relating to PREPA's Proposed Preferred Resource Plan

10. The Energy Bureau has summarized its Findings and Orders in this Part I. Details of each Finding and Order can be found within the Parts of this Resolution and Order that specifically address each of these matters.

11. The Energy Bureau **REJECTS** PREPA's Energy System Modernization (ESM) Plan as the Preferred Resource Plan because, as proposed, it does not demonstrate economic benefit relative to competing plans that PREPA has included in its Proposed IRP. The Energy Bureau **FINDS** that PREPA did not rely on the Net Present Value of Revenue Requirements (NPVRR) as the primary criterion when choosing a Preferred Resource Plan as required in Regulation 9021.

12. The Energy Bureau **FINDS** that five core elements of PREPA's ESM Scenario should be retained as part of a Modified Preferred Plan and Modified Action Plan, because they contain elements common to all plans and are "no regrets" actions. These actions are: timely conversion of older steam plant infrastructure to synchronous condensers, with the provision of dynamic reactive support, and stability and inertial characteristics for PREPA's system after installation of increased quantities of solar photovoltaics (PV); EE deployment, to the maximum amount obtainable as seen in "Full EE" scenarios; maximum procurement of solar PV in line with all scenarios; battery energy storage as an element of a Modified Preferred Resource Plan; and, hardening of the T&D system.

13. The Energy Bureau **REJECTS** PREPA's inclusion of approximately 400 MW of new fossil fuel peaking resources as part of the Preferred Resource Plan because it has failed to demonstrate that they are needed. However, the Energy Bureau **FINDS** that replacement of a small portion of the older gas turbine (GT) resources with peaking resources, using competitive procurement processes open to all technologies, is reasonable to provide local resource coverage to supplement the existing operating older GT units.

14. The Energy Bureau **FINDS** that PREPA has not fully supported the inclusion of a new gas-fired combined cycle (CC) unit at Palo Seco by 2025 as part of a least-cost plan. Notwithstanding the foregoing, to protect against the uncertainty of near-future solar PV and battery energy storage price outcomes, or other potential reliability concerns, out of an abundance of caution and coupled with strict oversight as detailed in this Final Resolution and Order, the Energy Bureau **FINDS** that PREPA may begin preliminary work on a new fossil fuel-powered unit and/or energy storage at Palo Seco, subject to the constraints set forth in the Modified Action Plan which includes among other things, a limitation for PREPA to spend up to $5 million for preliminary economic, siting, permitting, and planning analysis. The Energy Bureau **DETERMINES** that PREPA may expend up to five million dollars ($5 million) for preliminary economic, siting, permitting, and planning analysis regarding a new fossil fuel-powered unit at Palo Seco. The analysis shall include any associated infrastructure, including but not limited to

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

fuel delivery infrastructure. The Energy Bureau **WARNS** PREPA that it must be highly cost-efficient with any preliminary permitting and engineering activity it undertakes, and that these activities **SHALL NOT** interfere with or delay the procurement of solar PV (or other renewable energy) and battery energy storage resources as directed in the Modified Action Plan.

15. The Energy Bureau **FINDS** that increased deployment of solar PV and battery resources should be pursued if the results of procurement processes produce costs that reflect the parameters associated with Scenario S3S2 (for all loading levels under that scenario) and if those resources are available for faster installation than was assumed for PREPA's ESM Plan.

16. The Energy Bureau **FINDS** that a Modified Preferred Resource Plan for the purpose of initial procurement planning includes the solar PV and battery energy storage quantities contained in Scenario S3S2B for the first five years of the Action Plan period.

17. The Energy Bureau **FINDS** that for the purpose of determining the overall renewable energy resource installation goals for the PREPA system, the Modified Preferred Resource Plan includes the level of DG directly modeled as an input in all of PREPA's resource scenarios. The Energy Bureau **FINDS** that these quantities in total reflect the overall installation goals for PREPA's system, to be met through a combination of direct procurement, described herein through competitive request for proposal (RFP) processes, existing power purchase agreements, and through customer provision under the different options available to customers to provide their own energy.

18. The Modified Preferred Resource Plan is based on Scenario S3S2B and contains an increased level of solar PV and battery resources relative to PREPA's ESM Scenario, excludes the need for a new CC unit at Palo Seco, and excludes the new peaking resources included in PREPA's plan as a fixed decision. It includes EE and DR resources as modeled in PREPA's baseload forecast scenarios.

19. These determinations by the Energy Bureau will be reflected in the Modified Action Plan.

2. Determinations relating to PREPA's Proposed IRP Filing

20. The Energy Bureau has summarized its Findings and Orders in this Part I. Details of each Finding and Order can be found within the Parts of this Final Resolution and Order that address each of these issues.

a. Load forecasts

21. Section 2.03(C) of Regulation 9021 requires that "PREPA shall present a forecast of future capacity and energy demand requirements, as well as an analysis of prior load forecasts." PREPA must include a load forecast determination that includes: a forecast

of peak demand and energy for a reference case, and low and high baseline forecasts; historical peak demand and energy; a description of the load forecast methodology; an evaluation of the load forecast in the most recent IRP; and a load forecast analysis. The Energy Bureau **FINDS** that PREPA has met these requirements.

22. The Energy Bureau **FINDS** that PREPA did not correctly and clearly identify the variables used in the commercial sector load forecast, but the Energy Bureau has also determined that the net effects are relatively small. For future IRPs, including the next IRP, the Energy Bureau **ORDERS** PREPA to undertake further analysis of the commercial load forecast.

23. The Energy Bureau is concerned that PREPA did not include electric vehicle (EV) loads explicitly in its forecast but **FINDS** that the impact within the Action Plan period will be small and within the range of uncertainty expressed by the range of load forecasts examined. The Energy Bureau **ORDERS**, PREPA to develop and incorporate EV forecasts into the next IRP.

24. The Energy Bureau **ACCEPTS** PREPA's filed load forecasts for the purposes of this IRP.

b. Energy efficiency and demand response

25. Section 2.03(F)(3) of Regulation 9021 establishes that "[t]he IRP shall identify and include a wide range of potential new energy efficiency and demand response programs." The Energy Bureau **FINDS** that PREPA complied with this requirement.

26. The Energy Bureau **FINDS** that, based on the evidence presented in this proceeding, EE is expected to be a lower cost resource than any supply-side resource evaluated in this IRP.

27. For the next IRP, the Energy Bureau **ORDERS** PREPA to utilize the results of market baseline and potential studies that shall be conducted within the next year in developing projections of EE.

28. For the next IRP, the Energy Bureau **ORDERS** PREPA to compare the costs and performance of the efficiency programs modeled in the IRP with similar and best-practice programs elsewhere.

29. For the next IRP, the Energy Bureau **ORDERS** PREPA to account for federal appliance standards, building codes, and relevant governmental programs, such as weatherization assistance or Commonwealth programs to improve efficiency in government facilities, in developing its load forecast and efficiency projections.

30. The Energy Bureau **ACCEPTS** the evidence on the cost-effectiveness of DR that PREPA has presented, for the purposes of this IRP. However, the Energy Bureau **ORDERS** PREPA to promptly develop programmatic costs based on market response to the Energy Bureau's regulation of Demand Response after they are issued, and informed

NEPR NEGOCIADO DE ENERGÍA DE PUERTO RICO JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

by PREPA's process of negotiation, coordination, and scheduling with commercial and industrial customers as required by the Energy Bureau's Order and Resolution of May 22, 2020 in case NEPR-AP-2020-0001.

31. The Energy Bureau **ACCEPTS** PREPA's projection regarding the quantity of DR for the purposes of this IRP and **ORDERS** that distributed storage resources that can provide DR services be accounted for as part of the utility storage resource modeled in the next IRP.

32. For the next IRP, the Energy Bureau **ORDERS** PREPA to develop a DR resource projection that reflects information gained through implementation of the Energy Bureau's forthcoming regulations on Demand Response. The Energy Bureau **FURTHER ORDERS** PREPA to explicitly account for distributed storage resources as DR resources, as part of a virtual power plant (VPP), or both. As part of this projection, the Energy Bureau **FURTHER ORDERS** PREPA to account for the potential of interruptible load tariffs for large commercial and industrial customers.

c. Existing resource options – description and documentation

33. The Energy Bureau **FINDS** that pursuant to Section 2.03(D)(1)(a) of Regulation 9021, PREPA's IRP contained summary tables and descriptions of existing resources. The Energy Bureau therefore **DETERMINES** that PREPA's description of the existing resources **COMPLIES** with Sections 2.03(D)(1)(a) of Regulation 9021.

34. Pursuant to Section 2.03(D)(1)(b) of Regulation 9021, PREPA's Proposed IRP is required to provide supplemental information regarding PREPA's supply-side resources. The Energy Bureau **DETERMINES** that PREPA's description of the existing resources **COMPLIES** with Sections 2.03(D)(1)(b) of Regulation 9021).

35. Pursuant to Section 2.03(D)(1)(c), of Regulation 9021, PREPA's Proposed IRP is required to provide further additional supplemental information regarding PREPA's supply-side resources. The Energy Bureau **FINDS** that PREPA has not provided all of the elements required under Section 2.03(D)(1)(c) of Regulation 9021. PREPA has failed to provide annual anticipated non-environmental capital expenditures for the next ten (10) years. PREPA has identified how environmental regulations affected new resources; however PREPA does not provide the expected capital and operating costs for compliance with current, proposed, and reasonably anticipated regulatory and legal requirements. Finally, PREPA has not summarized supplemental information on important changes to resources that have occurred since the approval of the most recent IRP. The Energy Bureau therefore **DETERMINES** that PREPA's supplemental description of the existing resources **DOES NOT COMPLY** with Section 2.03(D)(1)(c). In the next IRP, the Energy Bureau **ORDERS** PREPA to comply with all requirements of Section 2.03(D)(1)(c).

d. Resource needs assessment

36. Regulation 9021[6] requires PREPA to assess its expected Planning Reserve Margin (PRM).[7] As part of that analysis, Regulation 9021 requires provision of a load and resource balance table for such existing conditions, inclusive of resource requirements considering a PRM in addition to a peak load forecast.[8] Regulation 9021 also requires identification of an "annual net position" relative to expected needs. Proposed IRP Section 5 as filed by PREPA does not directly provide an annual load and resource balance table for existing conditions, nor does it provide an "annual net position" under any set of resource or load combinations. The Energy Bureau **ORDERS** PREPA to provide these two elements in the body of its next IRP filing, with supporting data contained in workpapers.

37. The Energy Bureau **DETERMINES** that PREPA's resource need analysis has not sufficiently conveyed fundamental information concerning the amount of capacity that PREPA may need over the planning horizon. The Energy Bureau also **DETERMINES** that the underlying resource need can change depending on the decisions made to address optimal means to meet resiliency requirements.

e. New resource options – DG and utility-scale supply resources

38. The Energy Bureau **ACCEPTS** PREPA's assumption, for the purposes of the Proposed IRP process, that all generation options have the same affordable access to capital.

39. The Energy Bureau **FINDS** that the use of the uniform sixteen percent (16%) cost adder is **ACCEPTABLE** for the planning purposes of the Proposed IRP. For the next IRP, the Energy Bureau **ORDERS** PREPA not to rely on a cost factor of this sort, and instead base its analysis on the results of actual solicitations and market-available prices for development and installation in Puerto Rico.

40. The Energy Bureau **ACCEPTS** PREPA's assumptions regarding onshore wind for the purposes of planning in this IRP.

41. The Energy Bureau **ORDERS** PREPA to ensure that all RFPs open to solar PV also allow onshore and offshore wind to compete.

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[6] *See* Regulation 9021 §§ 2.03 (E)(1) and (2).

[7] The PRM is in general the amount of capacity available above peak load requirements during the time of peak load. It is usually expressed as a percentage of peak load. A minimum or threshold requirement for a PRM is usually defined as the level of capacity above peak load that is required in order to ensure reliable operations, based on a specific loss-of-load metric. Actual PRM is often or usually different from the specific minimum or threshold PRM requirement. If it is greater than the minimum threshold, there is surplus capacity; if it is less, there is a shortage of capacity.

[8] *See* Regulation 9021, Section 2.03 (E) (2).

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

42. The Energy Bureau **ORDERS** PREPA to conduct an offshore wind study tailored to Puerto Rico's wind resource and electric grid that evaluates the cost, generation profile, and other characteristics of anchored and floating wind turbine options, and submit the study to the Energy Bureau within two years from the date of this Final Resolution and Order. The Energy Bureau further **ORDERS** PREPA to solicit and incorporate feedback from the Energy Bureau regarding the scope for this study prior to issuing any RFP.

43. The Energy Bureau **FINDS** that the utility-scale battery energy storage cost and performance assumptions that PREPA made for the purposes of planning in the Proposed IRP are reasonable.

44. The Energy Bureau **FINDS** that PREPA's utility-scale solar PV costs as presented in the Proposed IRP for the purposes of planning are reasonable.

45. The Energy Bureau **ORDERS** PREPA to test the actual market-delivered price for energy storage, both as stand-alone installations and coupled with solar PV, through competitive procurement processes prior to determining the specific investments to make or contracts to sign. The Energy Bureau further **ORDERS** PREPA to use the results of competitive procurement processes to establish and/or confirm the storage costs assumed for modeling in all subsequent IRP proceedings.

46. The Energy Bureau **ORDERS** PREPA to use appropriate programmatic, market-based, and/or tariff-based tools to test the availability and cost of distributed storage resources. To the extent that a distributed storage resource is more cost-effective than utility-scale storage, the Energy Bureau **ORDERS** PREPA to utilize this resource. The Energy Bureau further **ORDERS** PREPA to use the results of its efforts to acquire distributed storage resources to provide grid services to inform its assumptions regarding the cost, availability, and performance of distributed storage in the next IRP proceeding.

47. The Energy Bureau **ORDERS** PREPA to use market pricing both to acquire solar PV, and to develop prices for use in its next IRP analyses.

48. The Energy Bureau **FINDS** that PREPA's analysis of the DG resource using a fixed forecast is reasonable for the limited purposes for which it is used in this proceeding.

49. The Energy Bureau **ORDERS** PREPA to take into account in the next IRP the impacts of DG deployment.

50. The Energy Bureau **ORDERS** PREPA to adapt its load forecast and procurement processes, to the extent that solar PV deployment rates are faster in Puerto Rico due to adoption of a different model for solar installation.

51. The Energy Bureau **ORDERS** PREPA to include, in the next IRP, a model of DG solar and storage adoption that accounts for the impact of PREPA rates and programs, along with Puerto Rico public policy, and reflects the risk of grid defection.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

52. The Energy Bureau **ORDERS** PREPA to quickly pursue VPP approaches to capture the grid value of distributed resources through RFPs, tariffs, rates, and/or direct utility programs.

f. Assumptions and forecasts

53. The Energy Bureau **FINDS** that PREPA's development of a range of possible outcomes for natural gas prices is reasonable.

54. The Energy Bureau **FINDS** the IRP's crude oil fuel forecast is reasonable.

55. The Energy Bureau **FINDS** that the Proposed IRP baseline delivered natural gas price for San Juan and Costa Sur based on the updated modeling runs provided by PREPA is reasonable.

56. The Energy Bureau **DOES NOT APPROVE** PREPA's proposed gas infrastructure since the Energy Bureau only authorized PREPA to begin preliminary work on new generation and/or energy storage at Palo Seco, subject to the constraints set forth in the Modified Action Plan.

g. Resource plan development documentation and analysis

57. The Energy Bureau **APPROVES** the specific "no regrets" elements, of (i) renewable energy and storage, (ii) maximization of EE provision, (iii) integration of DG, and (iv) hardening of aspects of the T&D systems, as forming the core of a Modified Preferred Resource Plan for PREPA.

58. The Energy Bureau **FINDS** that conversion of retired steam generating plants to synchronous condensers in support of voltage requirements that use increasing levels of inverter-based generation (from solar PV and battery energy storage) is reasonable, and **APPROVES** PREPA's plan to convert units to synchronous condensing operation, subject to PREPA's further plans for additional study and in a manner aligned with both steam plant retirement schedules and need.

59. The Energy Bureau **FINDS** that PREPA improperly excluded S3S2 from consideration as part of a Preferred Resource Plan based on PREPA's unfounded cost assumption concerns that can be addressed and tested as part of the competitive procurement processes set forth in the Action Plan. The Energy Bureau **FINDS** that the out-year concern regarding the level of solar as a percentage of peak load is of lesser importance when considering the additional load of battery energy storage during times of high solar PV output. The Energy Bureau further **FINDS** that these concerns are not sufficient to exclude S3S2 from consideration and can be addressed in subsequent IRP cycles.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

60. The Energy Bureau **ORDERS** PREPA to develop solar PV and battery storage resources at the S3S2B level in accordance with competitive procurement protocols as specified in the Modified Action Plan.

61. The Energy Bureau **ORDERS** that planned competitive procurement actions as included in PREPA's Action Plan must be undertaken to resolve the uncertainties regarding the likely actual costs for solar PV and battery storage resources.

62. The Energy Bureau **FINDS** that, from a climate change mitigation perspective, Scenario S3S2B is preferable to the ESM or S4S2B scenarios.

63. The Energy Bureau **FINDS** that PREPA's Proposed IRP does consider environmental impact assessments, in line with the provisions of Article 1.9(3)(H) of Act 17-2019, known as the *Puerto Rico Energy Public Policy Act*. Notwithstanding the foregoing, the Energy Bureau **ORDERS** PREPA in its next IRP to expand its evaluation of the environmental impact of its proposal , including climate change.

64. The Energy Bureau **FINDS** that PREPA should retire its older, oil-fired steam assets in order of the declining cost to operate when they are no longer necessary for system reliability. The retirements should align with synchronous condenser conversion.

65. The Energy Bureau **FINDS** that PREPA should retire Costa Sur units 5 and 6 when reliable system operation can be supported without their presence, after retirement of the oil-fired resources. The Energy Bureau **APPROVES** the retirement plans for PREPA steam units in accordance with PREPA's caveats and in accordance with the Modified Action Plan.

66. The Energy Bureau **ORDERS** PREPA to file quarterly updates and compliance reports associated with the plans for retirement of these units as set forth in the Modified Action Plan. The Energy Bureau **ORDERS** PREPA to include in these regular updates and compliance reports all information on the status of conversion to synchronous condensing where applicable.

67. The Energy Bureau **FINDS** that PREPA correctly determined that "[e]nergy efficiency is always the least cost resource and lower demand at far less cost than new supply and associated transmission and distribution."

68. The Energy Bureau **FINDS** that a maximum level of EE deployment should be a core provision of an approved Preferred Resource Plan.

69. The Energy Bureau **FINDS** that PREPA has not supported its claim that additional gas infrastructure at Mayagüez and Yabucoa, as contained in the ESM Scenario as a "fixed decision," is needed. The Energy Bureau **FINDS** that it is unreasonable in this IRP cycle to consider expenditures for such liquified natural gas (LNG) infrastructure as part of this IRP's preferred resource plan. The Energy Bureau **FINDS** that it is not reasonable in this IRP cycle to plan for such backup gas delivery locations.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

70. The Energy Bureau **FINDS** that PREPA did not rely on NPVRR as the primary criterion when choosing the ESM as its Preferred Resource Plan as required by Section 2.03(H)(2)(d)(i) of Regulation 9021. The Energy Bureau therefore **REJECTS** PREPA's ESM Plan as the Preferred Resource Plan.

71. The Energy Bureau **FINDS** that five core elements of PREPA's ESM Scenario are reasonable and should be retained as part of a Modified Preferred Resource Plan and Modified Action Plan, because they contain elements common to all plans and have been indicated by PREPA to be "no regrets" actions. The five core elements are: timely conversion of older steam plant infrastructure to synchronous condensers; EE deployment, to the maximum amount obtainable as seen in "full EE" Scenarios; maximum procurement of solar PV in line with all scenarios; battery energy storage as an element of a Modified Preferred Resource Plan—up to S3S2 levels; and hardening of T&D.

72. The Energy Bureau **FINDS** that PREPA's modeling results that include substantial needs for new solar PV and battery resources in the near- and longer-term for Puerto Rico fully support competitive procurement of these resources from among both utility-scale, and smaller, distributed scale VPPs, as long as technical specifications are met.

73. The Energy Bureau **FINDS** that PREPA has not supported the inclusion of approximately 400 MW of new fossil-fuel peaking resources in a least cost plan. Therefore, the Energy Bureau **DOES NOT APPROVE** PREPA's inclusion of these new peaking resources in a Preferred Resource Plan. The Energy Bureau **FINDS** that replacement of a small portion of the older GT resources with peaking resources, using competitive procurement processes and open to all technologies is reasonable, in order to provide local resource coverage supplementing the existing operating older GT units. The Energy Bureau **FINDS** that all Scenario analyses point to a broad conclusion that the underlying installation pace and cost of solar PV and battery energy storage procurement is a critically important piece of information, and ultimately would inform what the true least cost Scenario would be, in combination with confirming the costs associated with a new CCGT build at Palo Seco. The Energy Bureau **FINDS** that if solar PV and battery storage costs are roughly in line with the assumptions made for Scenario 3, and costs for a CCGT at Palo Seco remain as modeled (or are higher), then it is clear that S3S2B is the lowest cost plan and should directly inform PREPA's Preferred Resource Plan. As previously stated, to protect against the uncertainty of near-future solar PV and battery energy storage price outcomes, or other potential reliability concerns, out of an abundance of caution and coupled with strict oversight as detailed in this Final Resolution and Order, the Energy Bureau determined that PREPA may begin preliminary work a new fossil fuel-powered unit and/or energy storage at Palo Seco, subject to the constraints set forth in the Modified Action Plan.

74. The Energy Bureau **ORDERS** PREPA to submit quarterly reports, commencing no later than January 1, 2021, describing the work performed, the staffing or consultant

resources used to complete the preliminary work for a new CC at Palo Seco, and the status of the overall preliminary efforts.

h. Caveats and Limitations

75. The Energy Bureau **FINDS** that PREPA's inclusion of the caveats and limitations as required by Section 2.03 (I) of Regulation 9021 is reasonable.

76. The Energy Bureau **FINDS** that the caveats and limitations included as part of the Proposed IRP are reasonable in that it helps inform consideration of the Modified Resource Plan.

77. The Energy Bureau **FINDS** that PREPA's score card as presented in this Proposed IRP is not useful to compare the scenarios, and **ORDERS** PREPA to explicitly include specific quantitative weightings for any attribute, with accompanying explanation and rationale for any assigned weights, if PREPA chooses to use a score card in the next IRP.

i. Transmission and Distribution System

78. The Energy Bureau **FINDS** that microgrids form a critical part of the resiliency solutions envisioned for the Commonwealth. The Energy Bureau **ORDERS** PREPA to directly incorporate promotion of microgrid resources into all of its transmission, distribution, and resource planning exercises and all deployment actions taken in compliance with the modified Action Plan.

79. The Energy Bureau **FINDS** that PREPA has not demonstrated that all critical load must be served solely with thermal resources. There is no evidence provided by PREPA that solar PV and batteries could not supply a substantial portion of the actual critical load that exists across Puerto Rico, or that such resources could not provide real, tangible contributions to the provision of a sufficient level of resiliency for PREPA customers.

80. The Energy Bureau **FINDS** that there is no support for the stringency of PREPA's effective local capacity reserve requirement, whereby each of the eight MiniGrid regions must meet 75% of PREPA's forecast of as-defined "critical" peak load, with thermal capacity resources. The Energy Bureau **FINDS** that, as proposed, this requirement may lead to increased costs for capacity resources that are not necessarily needed for resiliency provision.

81. The Energy Bureau further **FINDS** that there is no support for PREPA'S capacity planning assumption that each of the eight MiniGrids must independently maintain this level of local thermal capacity reserve with no opportunity or consideration for power transfers between MiniGrids to contribute to meeting a portion of actual critical load.

82. The Energy Bureau **FINDS** that intervenor testimony compellingly demonstrates the inherent value of small-scale distributed resources in the form of microgrids, single-

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

site solar PV and battery storage, and aggregated solar PV and battery storage (or VPPs) for Puerto Rico as a critical part of an overall solution to ensure resiliency.

83. The Energy Bureau further **ORDERS** PREPA to include the ability of small-scale distributed resources that include solar PV and battery storage serving a portion of critical load to be part of its solution for ensuring a more resilient electric power system. The Energy Bureau includes as part of its Modified Action Plan an Optimization Proceeding to determine the optimized transmission investments associated with a scaled-down, refined and more optimal approach to considering MiniGrid transmission investment. The ability for small-scale distributed resources to contribute to resiliency needs is to be assessed as part of that proceeding.

84. The Energy Bureau **DETERMINES** that rapid deployment of points of distributed resiliency, including the use of microgrid, single-site solar PV and battery resources, or aggregated VPPs must form a part of PREPA's near-term approaches to developing a more resilient grid. The Energy Bureau **ORDERS** PREPA to provide analysis of the least cost options and incorporate such deployment, for the initial MiniGrid region chosen for analysis undertaken as part of the Optimization Proceeding discussed in the Modified Action Plan.

85. The Energy Bureau **FINDS** that PREPA's Value of Lost Load (VOLL) analysis demonstrates the importance of reducing longer-duration load loss, however, it provides no comparison of the cost-effectiveness across different approaches to reduce such lost load. The Energy Bureau **FURTHER FINDS** that that further analysis of least-cost methods is needed.

86. The Energy Bureau **ACCEPTS** the MiniGrid **concept** as a mechanism to provide resiliency during the loss of transmission or distribution system operations due to severe weather events. Nevertheless, the Energy Bureau **DOES NOT APPROVE** the MiniGrid design/construct, as proposed by PREPA, due to its lack of optimization of MiniGrid transmission system expenditures and distributed resiliency approaches. More specifically, the Energy Bureau **DOES NOT APPROVE** PREPA's assertion that the overall MiniGrid construct is a "least cost" approach to achieving resiliency against major hurricanes, because PREPA has not shown how its MiniGrid construct may be a less expensive approach than reasonable alternative approaches that include localized, distributed solutions along with an optimized level of MiniGrid-like T&D system expenditures.

87. The Energy Bureau recognizes the need for transmission system upgrades and therefore **ACCEPTS** PREPA's plans to spend up to $2 billion for transmission hardening of existing elements and aging infrastructure. However, this acceptance **SHALL NOT BE CONSTRUED** as an approval of the specific expenditures listed in the Proposed IRP. PREPA is **ORDERED** to timely seek the Energy Bureau's approval for the specific expenditures prior to making any final planning and investments.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

88. The Energy Bureau **FINDS** that PREPA did not properly consider an optimized transmission plan and **ORDERS** that the Modified Action Plan include the development of a resource plan or implementation strategy to optimize transmission spending. The Energy Bureau **ORDERS** PREPA to improve this aspect of its planning in the next IRP.

89. The Energy Bureau **CONDITIONALLY ACCEPTS** PREPA's plans for $911 million in distribution system investments for resiliency and support for DG. The Energy Bureau **ORDERS** PREPA to coordinate all distribution system spending with its ongoing efforts in integrated distribution system planning and maximizing the ability of the distribution grid to integrate DG, especially solar PV and batteries required throughout Puerto Rico as set forth in the Modified Action Plan. The Energy Bureau **ORDERS** PREPA to ensure that all voltage upgrades and voltage control additions to the distribution system explicitly focus on maximizing the ability of the system to support more DG and compliance with the Puerto Rico public policy. This acceptance **SHALL NOT BE CONSTRUED** as general approval. Accordingly, PREPA is **ORDERED** to timely seek the Energy Bureau's approval for the specific expenditures prior to making any final planning and investments.

90. The Energy Bureau **DIRECTS** PREPA to specifically consider how distribution system investments for resiliency may be modified to reflect an optimized approach to MiniGrid transmission investment. To that end, the Energy Bureau **ORDERS** PREPA to directly consider distribution system planning impacts in the Optimization Proceeding, discussed in the Modified Action Plan.

3. Approval of a Modified IRP with Modified Action Plan

91. Section 2.02(K)(2) of Regulation 9021 describes the purpose of the Action Plan as specifying the implementation actions required of PREPA during the first five years of the planning period, as set out in the Preferred Resource Plan. This section of Regulation 9021 also describes Action Plan Documentation and Development elements, including the need to document expected procurement processes for supply and demand-side resources, and to develop the Action Plan based on a Preferred Resource Plan that uses the lowest-cost net present value (NPV) of revenue requirements as its primary criterion.

92. This Modified Action Plan consists of specific directives to PREPA, including the following key components:

- Development by PREPA, with the Energy Bureau's guidance and approval, of a detailed procurement plan for renewable resources and battery energy storage. to achieve compliance with the renewable portfolio standard (RPS);
- Establishment of a new proceeding to explore how best to optimize potential distribution and transmission system expenditures in support of the MiniGrid concept if and where it would be most valuable and cost-effective for customers. This proceeding will include assessment of distributed

resource resiliency complementary to potential MiniGrid transmission investments;

- Determination of retirement schedules for older oil-fired generating units (with approval of conversion of some units to synchronous condensing operation), which will be dependent on achieving specific reliability milestones: completion of new battery energy storage capacity, potential additional peaking capacity, and obtaining DR resources and peak load reduction through EE provision;
- Determining the sequence of efforts required and allowed with respect to how PREPA conducts preliminary permitting and engineering for utilization of the Palo Seco site for generation, storage, or other uses. This action shall not in any way delay the completion of the first RFP issuance for renewable energy and battery energy storage resources;
- Establishing EE programs that grow from initial quick-start programs to aggressive and comprehensive approaches;
- Enabling of DR;
- Conditional approval of certain non-MiniGrid aspects of PREPA's T&D planning;
- Disapproval of certain "fixed decision" generation resource inclusions in PREPA's Proposed Action Plan; and
- Disapproval of related LNG infrastructure inclusions in PREPA's Proposed Action Plan.

93. Below is a summary of the Energy Bureau's key Findings and Orders as it pertains to the Modified Action Plan.

94. The Energy Bureau **ORDERS** PREPA to issue a series of RFPs for provision of renewable energy in support of Act 82's RPS goals, and for the provision of battery energy storage in support of capacity requirements needed to meet PREPA's peak load requirements and in support of integration requirements for renewable energy generation.

95. The Energy Bureau agrees that the installation of renewable energy and battery storage is a "no regrets" action and **FINDS** that maximizing the rate of adoption of solar PV and battery storage technology is clearly indicated from the modeling results of the Proposed IRP. The Energy Bureau **FURTHER FINDS** in favor of this "no regrets" action and **ORDERS** that the goal of maximizing the rate of solar PV installations and battery storage in Puerto Rico be achieved as part of the Modified Action Plan.

96. The Energy Bureau **FINDS** that PREPA's plan to use RFPs to solicit solar PV and battery energy resource capabilities in line with its need for these resources is **ACCEPTABLE**. The Energy Bureau also **FINDS** that competitive procurements to obtain Power Purchase and Operating Agreements (PPOA) for these resources **must be open to all forms of renewable energy, including, but not limited to wind, hydro, solar PV,**

VPP, and storage. The Energy Bureau **FURTHER FINDS** that PREPA should not unnecessarily limit the level of overall procurement to 250 MW blocks, but rather needs to pursue a strategy that attempts to procure the amount of resources required under S3S2B.

97. The Energy Bureau **ORDERS** PREPA to develop competitive solicitation processes for procurement of renewable resources and battery energy storage resources in support of "no regrets" findings for these resources from the IRP and in support of meeting Act 17 targets for renewable energy installations, and exceeding those targets where economical.

98. The Energy Bureau **ORDERS** PREPA to on or before sixty (60) days from the notification date of this Final Resolution and Order, submit a draft renewable resource and battery energy storage resource procurement plan (Procurement Plan) to the Energy Bureau. The Energy Bureau **FURTHER ORDERS** PREPA to file a status report on the development of its draft Procurement Plan no later than thirty (30) days from the notification date of this Resolution and Order with the information that is set forth in the Action Plan in Part V of this Final Resolution and Order.

99. The Energy Bureau **NOTIFIES PREPA** that explicit performance incentive metrics related to the timeliness and effectiveness of PREPA contracting and interconnection of resources may be included as part of ongoing metrics reporting requirements under Case No. NEPR-MI-2019-0007.

100. The Energy Bureau **ORDERS** PREPA to complete a feasibility study of refurbishing each of its hydroelectric facilities, including the expected cost and likely change in electricity production, as well as the potential to control production to produce at the times of greatest value in the context of increasing solar and battery storage. The Energy Bureau **ORDERS** PREPA to file the results of this study with the Energy Bureau, along with a proposed action plan for each facility informed by the study, within one hundred eighty days (180) days from the notification date of this Final Resolution and Order.

101. The Energy Bureau **APPROVES** PREPA's plans for retirement of the oil-fired steam resources over the next five (5) years, at San Juan, including units 7, 8, 9 and 10; at Palo Seco, including units 3 and 4 and at Aguirre including steam units 1 and 2. The Energy Bureau **ORDERS** this to occur during the term of this Modified Action Plan and **WARNS** PREPA that undue delays in the retirement of these units will result in stringent penalties.

102. The Energy Bureau also **APPROVES** PREPA's plans for retirement of the Aguirre CC units 1 and 2 over the next five (5) years.

103. The Energy Bureau **ORDERS** PREPA to file with the Energy Bureau bi-annual status reports, commencing on April 1, 2021, that provide a near-term forecast (two years forward of the reporting date) of PREPA's expected capacity resource balance on a

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

seasonal basis and its ability to meet peak load and operating reserve requirements with existing and anticipated resources on its system at each of the forecasted intervals.

104. The Energy Bureau **DOES NOT APPROVE** PREPA's plans for retirement of all eighteen (18) of the existing gas turbine peaking units located at Daguao, Yabucoa, Jobos, Vega Baja, Palo Seco, Aguirre, and Costa Sur and replacement with a new set of gas turbines (GT). As discussed in Part III(D) of this Final Resolution and Order, The Energy Bureau **FINDS** that it may be reasonable to consider some limited replacement, **but not a wholesale replacement of all units**. Therefore, the Energy Bureau **ORDERS** PREPA to establish a retirement schedule for the worst-performing of the 18 units and file this as part of the bi-annual status reports noted above for retirement of oil-fired steam and CC units.

105. The Energy Bureau **FINDS** that PREPA's plan to allow the repair and short-term operation of Costa Sur Units 5 and 6 is reasonable. The Energy Bureau **EXPECTS** that both units will eventually retire within this Modified Action Plan period as solar PV and energy storage becomes available. The Energy Bureau **ORDERS** PREPA to further include in the bi-annual status report, the status of the operating condition of each Costa Sur unit and how such status factors in to PREPA's overall generation plant retirement plans.

106. The Energy Bureau **APPROVES** PREPA's plans for continued operation and year-end 2027 retirement of the AES units in line with the Act 17 prohibition of coal fired generation starting in 2028.

107. The Energy Bureau **ACCEPTS** PREPA's renegotiated EcoEléctrica PPOA and Naturgy Natural Gas Sale and Purchase Agreement.

108. The Energy Bureau **ACCEPTS** PREPA's conversion of the San Juan Units 5 and 6 to burn natural gas as a fixed decision (constraint) in the Proposed IRP. The New Fortress Energy contract expires in 2025. Accordingly, the Energy Bureau **ORDERS** PREPA to include the renewal and extension of the New Fortress Energy contract as an option, not as a constraint, in the next IRP.

109. The Energy Bureau **DENIES** the conversion of the 200 MW Mayagüez peakers to burn natural gas. However, the Energy Bureau **ORDERS** PREPA to retain the peakers. Since the units are a recent vintage (2009) generation resource,[9] there is no expectation that their economic or age-related retirement might occur during the Modified Action Plan period.

110. The Energy Bureau **DOES NOT APPROVE** the inclusion of a new CC at Palo Seco as a component of PREPA's Action Plan. However, as stated above, to protect against the uncertainty of near-future solar PV and battery energy storage price outcomes, or other

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[9] *See* Proposed IRP, page 4-1. Commercial operation date is 2009.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

potential reliability concerns, out of an abundance of caution and coupled with strict oversight as detailed in this Final Resolution and Order, the Energy Bureau **FINDS** that PREPA may begin preliminary work on a new fossil fuel-powered unit and/or energy storage at Palo Seco, subject to the constraints set forth in the Modified Action Plan.

111. PREPA has not supported its claim that additional gas infrastructure at Mayagüez and Yabucoa as contained in the ESM Scenario as a "fixed decision" is needed. The Energy Bureau therefore **ORDERS** PREPA not to expend resources on the siting, permitting, procurement, engineering, design, or other preliminary work for LNG infrastructure or new fossil-fuel powered generation facilities at Yabucoa or Mayagüez.

112. The Energy Bureau **FINDS** that replacement of a portion of PREPA's older gas turbine resources with peaking resources is consistent with this Modified Action Plan, subject to a number of constraints more fully set forth in Part V. These include a competitive bid open to all single or aggregated source of demand and supply-side options of no more than 81 MW, among other directives.

113. PREPA's Proposed Action Plan includes only a general call to establish EE programs and pursue savings of two percent (2%) per year. The Energy Bureau **FINDS** that the Action Plan for the IRP must contain greater detail and specificity than that provided by PREPA. As part of the Energy Bureau's mandate to pursue least cost energy systems for Puerto Rico, and in support of the objective of thirty percent (30%) EE savings by 2040 enshrined in Act 17. Therefore, the Energy Bureau **REJECTS** PREPA's Action Plan regarding EE. The Energy Bureau **ORDERS** that this Modified Action Plan support the Energy Bureau's objective for EE programs to capture all available cost-effective EE. The Energy Bureau **ORDERS** PREPA to organize and coordinate the necessary resources to timely comply with and facilitate the successful implementation of the EE Regulation.

114. The Energy Bureau **MODIFIES** the Action Plan regarding DR. Consistent with the Modified Action Plan components regarding distributed storage and VPPs, PREPA **SHALL DEVELOP**, with the Energy Bureau's guidance and approval, internal systems as well as external programs, offerings, and/or solicitations to engage aggregators of DR resources to offer, dispatch, and be compensated for cost-effective DR resources. This shall be available to all customer classes.

115. The Energy Bureau **ACCEPTS** the MiniGrid **concept** as a mechanism to provide resiliency during the loss of transmission or distribution system operations due to severe weather events. Nevertheless, the Energy Bureau **DOES NOT APPROVE** the MiniGrid design/construct as proposed by PREPA due to its lack of optimization of MiniGrid transmission system expenditures and distributed resiliency approaches.

116. The Energy Bureau **FINDS** that part of the Modified Action Plan will be the establishment of a framework for resilient system operation at reasonable cost that includes the following elements: preservation of the option to better optimize T&D

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

system expenditures for resiliency, including aspects of PREPA's MiniGrid concept; review and elaboration on the definition and identification of different classes of customers regarding the criticality of electricity service, and associated expected levels of resiliency; emphasis on the central role that customers can play through provision of energy supply and DR; and, provision of microgrid and related single-site (individually, or in the aggregate as VPPs) local capacity and energy solutions for both resiliency provision and contribution to energy and capacity needs during normal periods, in accordance with Act 17 promotion of microgrids and distributed energy resources.

117. The Energy Bureau will open a MiniGrid Optimization proceeding (Optimization Proceeding) following the issuance of this Final Resolution and Order. The Energy Bureau **FIND**S that this proceeding will be the forum to further explore the costs, benefits, and alternative configurations of combinations of wires (*i.e.*, hardened T&D assets) and local distributed resources that best serve Puerto Ricans in safeguarding against the effects of short-term and extended electric system outages that can occur as a result of severe weather events. The Energy Bureau **EXPECTS** that this proceeding will commence in the Fall of 2020.

118. The Energy Bureau **ESTABLISHES** the San Juan/Bayamón region as the first MiniGrid region to be considered for optimization due to the relative density of load in that region. Notwithstanding the foregoing, the Energy Bureau is open to stakeholder or PREPA duly justified suggestions as to whether a different MiniGrid region or other zone might be better examined initially.

119. The Energy Bureau **ACCEPTS** as part of the Modified Action Plan the portion of PREPA's proposed Action Plan that included prioritized expenditures to bring existing transmission system assets up to current or new Standards, as seen in the Proposed IRP Exhibit 10-11, and totaling $1.15 billion through 2025. However, this acceptance **SHALL NOT BE CONSTRUED** as an approval of the specific expenditures listed in the Proposed IRP. PREPA is **ORDERED** to timely seek the Energy Bureau's approval for the specific expenditures prior to making any final planning and investments.

120. The Energy Bureau **DISAPPROVES**, at this time, the $5.9 billion in MiniGrid expenditures, as proposed by PREPA. In the Optimization Proceeding noted above, the Energy Bureau will consider transmission needs associated with an optimized MiniGrid transmission system and establish the appropriate MiniGrid and related transmission expenditures.

121. The Energy Bureau **ORDERS** that the Modified Action Plan include distribution system investment and analysis including integration of DG in accordance with the findings in Part III(I) and the discussion in the Action Plan.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

4. Preparation for the next IRP cycle

122. PREPA must continue to improve its resource planning process. The Final Resolution and Order in the last IRP proceeding directed PREPA to (a) make internal improvements to its planning procedures; (b) select a new IRP consultant competitively, subject to Energy Bureau oversight and approval; and (c) develop procedures for collecting key data on the performance of its electric system.[10] The Energy Bureau **FINDS** that PREPA has made improvements to its resource planning process and **DIRECTS** PREPA to continue to do so in the next IRP, and specifically to follow the Energy Bureau's guidance as set forth in Part V of this Final Resolution and Order. The Energy Bureau further **FINDS** that PREPA is in noncompliance with the directives to select a new IRP consultant and to conduct a competitive bid process. The Energy Bureau **ORDERS** PREPA to conduct a competitive bid process for the next consultant for the IRP. With respect to collecting data on key performance indicators, the Energy Bureau **FINDS** that PREPA has developed good key performance indicators but has not been consistent in providing quarterly reports with all the data. PREPA should continue to do so in accordance with the Energy Bureau's directives in the docket that expressly addresses this.[11]

B. Statutory Goals and Requirements

123. The Puerto Rico Legislature has been actively engaged in developing solutions and mechanisms to improve the energy situation in Puerto Rico. Through many legislative bills discussed below, the Legislature has woven a strong, cohesive message to reduce energy costs, and to diversify the energy portfolio through greater reliance on renewable energy and decentralized clean energy options such as DG, microgrids, EE, and DR. The Energy Bureau is mindful of the legislative mandate to carry out these policies as it reviews PREPA's Proposed IRP. Some of the key provisions of legislation that address issues relevant to the Proposed IRP are highlighted below.

1. Act 82-2010, known as the Puerto Rico Energy Diversification Policy through Sustainable and Alternative Renewable Energy Act

124. Act 82-2010, as amended, (Act 82) established the first renewable energy portfolio standard in Puerto Rico and required that a retail energy provider procure twelve percent (12%) of its power needs through renewable energy by 2015, fifteen percent (15%) by 2020 with a goal of reaching twenty percent (20%) by 2035.[12] Act 82 was

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[10] Final Resolution and Order, In Re: Integrated Resource Plan for the Puerto Rico Electric Power Authority, Case. No. CEPR-AP-2015-0002, September 23, 2016.

[11] Resolution and Order, In Re: The Performance of the Puerto Rico Power Authority, Case No. NEPR-MI-2019-0007, May 14, 2019.

[12] *See* Act 82, Statement of Motives.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

amended in 2019 to, among other things, establish new RPS milestones: twenty percent (20%) by 2022, forty percent (40%) by 2025, sixty percent (60%) by 2040 and one hundred percent (100%) by 2050.[13] Act 82 created Renewable Energy Certificates (RECs) that encompassed all the environmental and social attributes of one megawatt-hour (MWh) of electricity and that could be traded beyond the borders of Puerto Rico.[14]

2. Act 83-2010, known as the *Puerto Rico Green Energy Incentives Act*, as amended

125. Act 83-2010, as amended, (Act 83) was established to among other things: achieve the diversification of energy sources; reduce the dependency on fossil fuels; reduce and stabilize energy costs; reduce the flight of capital caused by the import of fossil fuels; and preserve and improve the environment.[15] Act 83 also created a Green Energy Fund to fund the development of sustainable energy systems that further energy use savings and efficiency.[16] The legislation also contained Green Energy Initiatives and tax benefits to encourage consumers and businesses to use renewable energy.[17]

3. Act 57-2014, known as the *Puerto Rico Energy Transformation and RELIEF Act*, as amended.

126. Act 57-2014(Act 57) was passed to provide governance of PREPA through the creation of an independent regulatory body; and to establish strategic planning and information requirements to promote transparency and active citizen participation. In the "Statement of Motives" of Act 57, the Legislature stated in pertinent part, the following:

> …there is a broad consensus on the need to evolve our dependence on fossil fuels and use to the maximum extent possible the Island's energy resources such as the sun and the wind, conservation, and efficiency.
>
> ….
>
> The high cost of energy limits our ability to stimulate the economy, strengthen small- and medium- sized businesses, as well as to attract private sector investors from abroad, develop commercial, industrial, and manufacturing activities, and improve the quality of life for all Puerto Ricans. This prevents our island from becoming a competitive and attractive place in all aspects. We have been held as hostages of a poorly efficient energy system that excessively depends on oil as a fuel

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13 *See* Act 17-2019, Statement of Motives.

14 *See* Act 82, Statement of Motives.

15 *See* Act 83 § 1.2.

16 *Id.* at § 2.1.

17 *Id*. at Statement of Motives.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

> and that does not provide the tools to promote our Island as a place of opportunities in the global market. The current cost per kilowatt (kW) of approximately twenty-seven cents ($.27) is extremely high when compared to other jurisdictions that compete with Puerto Rico to attract investors and severely affects the pockets of local consumers.[18]

127. Essential to carrying out this legislative intent is a plan and a planning process, directed and overseen by the Energy Bureau. Act 57 thus requires PREPA to submit, and the Energy Bureau [19] to approve, an integrated resource plan, defined as:

> … a plan that considers all reasonable resources to satisfy the demand for electric power services during a specific period of twenty (20) years, including those related to the offering of electric power, whether existing, traditional, or new resources, and those related to energy demand, such as energy conservation and efficiency, or DR and localized energy generation by the customer. Every integrated resource plan shall be subject to the rules established by PREB and approved by the same. Every plan shall be devised with a broad participation from citizens and other interested groups.[20]

128. The Energy Bureau regulation[21] defines the term "Integrated Resource Plan" or "IRP" as follows:

> [A] plan that considers all reasonable resources to satisfy the demand for electric power services during a specific period of time, including those relating to the offering of electric power, whether existing, traditional, and/or new resources, and those relating to energy demand such as energy conservation and efficiency or DR and localized energy generation by the customer, while recognizing the obligation of compliance with laws and regulations that constrain resource selection.[22]

129. Under Article 6.23 of Act 57, the Energy Bureau has the mandate to establish regulations to govern the IRP that PREPA is required to file. The IRP is the centerpiece for carrying out the legislative intent to evolve the energy sector so it is less reliant on expensive fossil fuels, utilizes more utility scale and distributed renewable energy, and

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[18] *See* Act 57, Statement of Motives.

[19] The Puerto Rico Energy Commission was created under Act 57 and was later renamed the Puerto Rico Energy Bureau. *See* Act 211-2018.

[20] *See* Act 57 § 1.3 (ll).

[21] *Regulation on the Integrated Resource Plan for the Puerto Rico Electric Power Authority*, April 24, 2018 ("Regulation 9021").

[22] *See* Regulation 9021, § 1.08(B)(20).

promotes efficiency and conservation so as to improve the environment, comply with federal laws addressing clean air and manage the cost of electricity. The goal of an IRP and this proceeding is to evaluate PREPA's resources in order to develop a cost-effective (least cost) plan to meet Puerto Rico's energy needs in the future. The 2015 IRP set forth a plan to begin the retirement of old, costly power plants and to replace them with lower cost more efficient plants, specifically with renewable resources, implementing cost-effective EE and DR programs, and promoting DG technologies such as rooftop solar. The purpose of this proceeding is to build on the progress made in the 2015 IRP and to move in the direction of a lower cost energy future that meets the legislative goals of making Puerto Rico's energy costs more competitive in a global market.

4. Act 120-2018, known as the *Puerto Rico Electric Power System Transformation Act*, as amended.

130. Act 120-2018, 120) created the legal framework required for the sale, disposition, and/or transfer of the assets, operations, functions, and services of PREPA.[23] Act 120 was passed in recognition of the many deficits in the energy system operated by PREPA, including among other things, "…the high cost of fuel in a very volatile and speculative market; an old and deteriorated electric power infrastructure dependent on the costliest, less efficient, and most polluting fuels;…"[24] The Legislature delineated the issues with the power system that require correction, by noting:

> Although the Electric Power Authority operates as a Government monopoly, it lacks the conditions to offer an efficient service at a reasonable cost for residential, commercial, and industrial customers. Given the budgetary and financial uncertainties that have accumulated over the last decade, neither PREPA nor the Government have the necessary financial resources to carry out its operational restructuring, achieve financial recovery, and make the substantial infrastructures changes it requires.[25]

131. To address the transformation, the Legislature utilized the Public-Private Partnerships (P3)[26] Authority to conduct negotiations for the purpose of addressing the financial viability of PREPA. Under Act 120, any contract related to a PREPA Transaction has to

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[23] *See* Act 120, Statement of Motives.

[24] *Id*.

[25] *Id*.

[26] The Public-Private Partnership is defined as: "Any agreement between a Government Entity and one or more Persons, subject to the public policy set forth in this Act, the terms of which are provided under a Partnership Contract, to delegate operations, functions, services, or responsibilities of any Government Entity, as well as to design, develop, finance, maintain or operate one or more Facilities, or any combination thereof." *See* Act 29-2009, known as the *Public-Private Partnership Act*, §1(b).

obtain an Energy Compliance Certificate from the Energy Bureau.[27] Moreover, the legislation grants PREPA and the P3 the authority to sell PREPA assets related to electric power generation and to transfer or delegate any of PREPA's operations, functions, or services. The legislation also notes, however, that the regulatory framework must be consistent with the new realities in Puerto Rico and the energy industry; it must therefore, among other things, allow for the use of DG, microgrids, and more renewable energy. The Legislature also notes that the electric system must be resilient to weather events and the effects of climate change on the Island. Act 120-2018 also points out "…the importance of regulating the energy industry and the need to have an independent regulatory entity that carries out its duties firmly and resolutely."[28]

5. Act 17-2019, known as the Puerto Rico Energy Public Policy Act

132. Act 17-2019 (Act 17) built upon the foundation created for integrated resource planning in Act 57 and sharpened the focus on accelerated renewable energy provision, energy conservation and efficiency, DR, and DG.[29] In so doing, Act 17 increased the renewable portfolio to a minimum of twenty percent (20%) by 2022, forty percent (40%) by 2025, sixty percent (60%) by 2040 and one hundred percent (100%) by 2050[30] and created an energy efficiency target of thirty percent (30%) by 2040.[31] Act 17 also emphasizes the role of "prosumer" generation, and envisions an enhanced role for microgrids.[32] Further, Act 17 reinforces the authority of the Energy Bureau to conduct IRP proceedings.[33] Act 17 also states that the IRP will be prepared by the electric power company responsible for the operations of the electrical system and shall be approved by the Energy Bureau.[34] Allowance for preparation by an entity other than PREPA acknowledges the changes contemplated under future IRPs as a result of the implementation of Act 120. The legislation also set forth more detail than that contained within Act 57 on the content of the IRP,[35] but the content requirements are

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[27] *See* Act 120, § 5(g).

[28] *Id.* at Statement of Motives.

[29] *See* Act 17, § 1.2(p).

[30] *Id.* at § 1.6(7).

[31] *Id.* at § 1.6 (10).

[32] *Id.* at § 1.2(r).

[33] *Id*.

[34] *Id.* at § 1.9(1).

[35] *Id.* at § 1.9(3); § 5.18 amending § 6.23 of Act 57.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

consistent with the Energy Bureau's IRP requirements contained in Regulation 9021.[36] A central point throughout the legislation is that actions taken regarding generation and related matters must conform to the approved IRP, thereby highlighting the importance of the IRP as a central planning tool. Any changes or amendments to the IRP shall be approved by the Energy Bureau.[37]

6. Summary of how Modified Action Plan addresses legislative goals and requirements

133. Over the past several years, as discussed above, the Puerto Rico legislature has passed legislation designed to improve Puerto Rico's energy system, to make it more resilient, more affordable, less reliant on fossil fuel and better able to meet clean energy objectives, including combatting climate change. The Modified Action Plan fully complies with these objectives.

134. With respect to resilience, the Modified Action Plan accepts the MiniGrid concept, but not PREPA's MiniGrid proposal and supports further analysis and study through the establishment of a new proceeding to explore how best to optimize potential transmission system expenditures in support of the MiniGrid and to ensure cost-effectiveness. The Modified Action Plan also includes distribution system investment and analysis including integration of DG. Further, with respect to resiliency, the Modified Action Plan includes additional elements such as: review of the level of criticality for electric service in the different customer classes; emphasis on the central role that customers can play through provision of energy supply and DR; and, the provision of microgrid and related single-site (individually, or in the aggregate as VPPs) local capacity and energy solutions, in accordance with Act 17, as well as promotion of microgrids and distributed energy resources.

135. With respect to affordability, the Energy Bureau found that energy efficiency is the least cost resource and therefore in support of the objective of thirty percent (30%) EE savings by 2040 set forth in Act 17, the Energy Bureau has ordered that the Modified Action Plan establish EE programs to capture all available cost-effective EE. This includes quick start programs capable of ramp-up to more aggressive levels of EE. Further, The Modified Action Plan also orders to develop programs, offerings and/or solicitations regarding distributed storage and VPPs, to engage aggregators of DR

[36] *See Regulation on the Integrated Resource Plan for the Puerto Rico Electric Power Authority*, April 24, 2018 (Regulation 9021). Regulation 9021 is the culmination of a rulemaking proceeding in which comments were sought by interested stakeholders. *See*, Regulation of the Integrated Resource Plan of the Puerto Rico Electric Power Authority, CEPR-MI-2018-0005, February 8, 2018. Note that Regulation 9021 superseded Regulation 8594, which was expeditiously enacted in order to provide guidance to PREPA to meet the statutory deadline to file its first IRP by July 1, 2015. The experience gained during the previous IRP proceeding, allowed the Energy Bureau in Regulation 9021, to improve, expand and elaborate on the requirements set forth in Regulation 8574.

[37] *Id.* at Section 1.9(2).

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

resources to offer, dispatch, and be compensated for cost-effective DR resources. Given that this will be available to all customer classes, it creates an opportunity for customers to reduce their energy bills. The Energy Bureau is also requiring competitive bidding for all new resources and enabling all resources to bid as a means of obtaining the best, low cost resources to serve Puerto Rico's energy needs into the future.

136. The Modified Action Plan includes a number of directives to retire fossil fuel plans consisting of the retirement of the oil-fired steam resources over the next five (5) years, at San Juan, including units 7, 8, 9 and 10; at Palo Seco, including units 3 and 4 and at Aguirre including steam units 1 and 2; and, the plans for retirement of the Aguirre CC units 1 and 2 over the next five (5) years. Further, the Modified Action Plan rejects PREPA's proposed LNG infrastructure development at Mayagüez and Yabucoa.

137. With respect to clean energy and climate change, the Modified Action Plan places an emphasis on Solar PV and battery storage with PREPA being required to issue a series of RFPs for provision of renewable energy in support of the RPS goals of Act 82, and for the provision of battery energy storage in support of capacity requirements needed to meet PREPA's peak load requirements. Further, in support of integration requirements for renewable energy generation, competitive procurements to obtain PPOAs for these resources must be open to all forms of renewable energy, including, but not limited to wind, hydro, VPP, solar PV and storage. Finally, the EE and DR discussed above will contribute to a reduction in emissions which with benefit the environment and contribute to slowing climate change.

C. Regulations of the Energy Bureau Relevant to these Proceedings

1. Integrated Resource Plans

138. PREPA is required to file before the Energy Bureau an IRP that is compliant with the provisions of Regulation 9021. Among the features of Regulation 9021 is the establishment of new procedures to allow for more public participation and increased transparency in the development of the IRP. Specifically, the IRP process is separated into two phases. Section 3.01 sets forth the process for Phase 1, which is the IRP pre-filing phase.[38] In Phase 1, the Energy Bureau may require one or more technical conferences for the purpose of gathering, "information regarding the methodology and content contemplated by PREPA for its new IRP proposal."[39] The purpose of the technical conference is clearly articulated in the regulation and demonstrates the basis for creating a two phase proceeding:

[38] *See* Regulation 9021, §3.1(A)(1).

[39] *Id*. at §3.01(A)(2).

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

> The purpose of these technical conferences is to provide an opportunity for the [Energy Bureau] to ensure PREPA's IRP filing will reasonably comply with the requirements set forth in this Regulation and the analysis conducted therein will be sufficiently robust so as to comply with public policy goals and meet [Energy Bureau] expectations as to the quality of the analysis and information provided. These proceedings will also provide an opportunity for PREPA to seek clarifications from the [Energy Bureau] with regards to compliance with the requirements set forth in this Regulation.[40]

139. Phase 2 of the proceeding commences once PREPA files its IRP. The first step is for the Energy Bureau to review the IRP to ensure that the filing is complete (*i.e.*, compliant with applicable filing and content requirements).[41] Regulation 9021 requires PREPA to include an assessment of the planning environment, a careful and detailed study of a range of future load forecasts, present generation resources, present demand resources, current investments in electricity conservation technologies, existing T&D facilities, and the relevant forecast and scenario analyses in support of PREPA's selected resource plan , among other things. The IRP filing must also contain a proposed Action Plan for the implementation of the Preferred Resource Plan.[42]

140. The objective of Regulation 9021 is to ensure that the IRP serves as a useful tool in the development of a comprehensive plan for a portfolio of least-cost resources to serve Puerto Rico's electric power system, and to improve the system's reliability, resiliency, efficiency, and transparency. The provisions established therein guide the IRP process and are consistent with the legislative mandates discussed in Part I(B) above. Regulation 9021, moreover, defines the terms related to the information required in the IRP, the procedures before the Energy Bureau, and the performance metrics guideline and inducements that PREPA will follow after the Energy Bureau has evaluated and reviewed the IRP. The Energy Bureau will evaluate the IRP as well as PREPA's performance thereafter in accordance with the provisions set forth in Regulation 9021 and its Regulation for Performance Incentive Mechanisms.[43]

2. Microgrid Regulations

141. In response to Hurricane María and the need to deploy energy services to rural areas where people were suffering from an enduring lack of energy services, the Energy

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[40] *Id*.

[41] *Id.* at §3.02.

[42] *Id.* at §§ 1.03 and 2.03(K).

[43] *Id.* at §§ 1.03 and; § 5.01; *See* Regulation 9137, *Regulation for Performance Incentive Mechanisms*, December 2, 2019.

Bureau promptly enacted microgrid regulations to guide developers and the public.[44] Regulation 9028 created a certification process[45] and addressed the development of microgrids through the classification of personal ownership, co-operatives and third-party developers.[46] The rules were designed to spur the development of microgrids while also providing consumer protections, especially with third-party developers.[47]. Puerto Rico's microgrid regulations were the first microgrid regulations ever created in the United States. These regulations furthered the objectives of the Legislature to promote the decentralized resource options that are being considered in the IRP.

3. Energy Efficiency and Demand Response Regulations

142. In accordance with the provisions of Act 57 and Act 17, the Energy Bureau has been taking steps to prioritize EE and DR. The first set of IRP regulations set forth requirements for consideration of EE as an integral part of the IRP.[48] In the 2015 IRP proceeding, the Energy Bureau ordered PREPA to model EE growth in order to measure its potential impact on demand and the supply resources needed. Regulation 9021 establishes protocols for periodic filings on EE programs, and renew the requirement that EE and DR programs be implemented by a Third-Party Administrator.[49] Since the passage of Act 17, the Energy Bureau has conducted workshops to explore various aspects of EE including funding mechanisms. On September 4, 2019, the Energy Bureau opened a docket for regulations on Energy Efficiency and Demand Response.[50] The Energy Bureau continues to work on revisions to these regulations and expects to release proposed regulations again in the coming months. In the interim, the Energy Bureau required PREPA to model EE savings of two percent (2%) per year from 2020 through 2037, with a goal of reaching thirty percent (30%) EE in 2040 as required by Act 17,[51] as well as no EE (No EE) and low EE (Low EE) cases.

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[44] *See* Regulation 9028.

[45] *See* Regulation 9028, *Regulation on Microgrid Development*, §§ 4.03, 5.02, 5.03.

[46] *Id.* at § 2.01.

[47] *Id. at* §§ 5.04 -5.11.

[48] *See* Regulation 8594, Article IV.

[49] *See* Regulation 9021, § 4.01.

[50] Resolution, In Re: Regulation for Energy Efficiency and Demand Response, Case No. NEPR-MI-2019-0015, September 4, 2019.

[51] *See* Act 17, § 1.6 (11).

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

4. Performance Incentive Mechanisms Regulations

143. On November 15, 2016, the Energy Bureau issued a "Notice of Investigation to Identify Opportunities to Improve Performance of the Puerto Rico Electric Power Authority."[52] On December 11, 2019, in accordance with Act 57, the Energy Bureau issued a Resolution adopting the Regulation for Performance Incentive Mechanisms for certified electric service companies.[53] Regulation 9137 set forth the process for proceedings to establish: specific metrics, targets, financial incentives and penalties[54] and reporting requirements.[55] Regulation 9021 also addresses performance incentive mechanisms and requires PREPA to:

> …include a general narrative of the key performance metrics required by the Commission and also identified in Section 6B(h)(iv) of Act 83, its performance with regards to such metrics and a comparison of its results with those achieved by similarly sized and comparable utilities. Furthermore, as described in Section 2.03(J)(1)(a)(v), PREPA's Action Plan shall include a description of the anticipated impact of each resource action on any applicable performance metrics.[56]

144. These metrics will be important tools for the Energy Bureau to utilize to ensure that the Modified Action Plan stemming from this IRP is fully implemented in a timely manner.

D. Goals and Objectives of the IRP

145. An IRP is an electric power utility's guidebook for providing least-cost electric service over the planning horizon, in this context twenty (20) years. Its purpose is to develop a plan for the least costly options to serve customer demand, taking into account other important policy objectives such as resiliency, reliability, and the goals of the utility, the government, society, and the environment. "Least-cost" refers to the least-cost-net-present value of revenue requirements taken at present value from the present day to the end of the analysis period. As part of the IRP process, the utility assembles data on

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[52] Resolution, In Re: The Performance of the Puerto Rico Electric Power Authority, Case No. CEPR-IN-2016-0002, November 16, 2016.

[53] *See* Regulation 9137, *Regulation for Performance Incentive Mechanisms*, December 2, 2019.

[54] *Id*. at § 3.1.

[55] *Id.* at § 4.01.

[56] *See* Regulation 9021, § 5.01.

its existing resources,[57] historical customer demand[58] and electricity loads. It uses the minimization of revenue requirements as its priority criterion, but also considers such factors as: system reliability; short and long-term risks; environmental impacts; T&D needs and implications; financial implications on PREPA; and, the public interest.[59] An IRP has been described as "the culmination of a comprehensive utility planning process that evaluates the merits of using different kinds of energy resources to meet forecasted future demand for electricity with the goal of meeting demand reliably and cost effectively."[60]

146. The IRP process should be transparent and provide an opportunity for stakeholders to participate fully. The Action Plan which springs forth from the IRP creates the path for future actions the utility may take. However, it is not cut in stone, and it should be flexible enough to be amended in the event of unforeseen circumstances, like Hurricane María. It should also be subject to amendment or reconsideration in a new IRP proceeding as warranted. Act 57 requires that every three years, PREPA file a new IRP,[61] as does Act 17;[62] given the substantial and unforeseen impacts of Hurricane Irma and María, however, the IRP under consideration in this proceeding has been filed earlier.

147. Act 17 provides clear guidance on the definition of the IRP, defining it as a plan:

> ....that considers all reasonable resources to satisfy the demand for electric power services during a specific period of time, including those related to energy supply, whether existing, traditional, and/or new resources, and those related to energy demand, such as energy conservation and efficiency, DR, and DG by industrial, commercial, or residential customers. Every integrated resource plan (IRP) shall be subject to the provisions of this Act and the rules established by the Bureau which shall approve the same. Every plan shall be devised with broad participation from citizens and all interested groups.[63]

148. Act 17 requires that the IRP "describe the combination of energy supply and conservation resources that satisfies the present and future needs of the energy system

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[57] "Resources" includes generation, distribution, transmission, energy efficiency programs, demand -response programs and customer resources like distributed generation and microgrids.

[58] "Customer Demand" in this context means the amount of electricity consumed at a given time in a utility's electric service territory, measured in GWh.

[59] *See* Regulation 9021, § 2.03(H)(2)(d).

[60] *Kentucky Coal Association, Inc. v. Tennessee Valley Authority*, 68 F. Supp. 3d 703, 707 (2015).

[61] *See* Act 57, § 2.9(h)(i).

[62] *See* Act 17, § 1.9(2).

[63] *See* Act 17, § 1.2(p).

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

of Puerto Rico at the lowest reasonable cost possible."[64] Act 57 also requires that the IRP be comprehensive with respect to the evaluation of the electricity system, and must include (a) a range of future demand forecasts; (b) an evaluation of conservation resources (*i.e.*, demand-side management options); (c) a range of conventional and non-conventional generation technologies available in the market; (d) an evaluation of the T&D system; (e) a comparative evaluation of energy resources and T&D; (f) an evaluation of resources designed to diversify and stabilize energy costs and improve reliability and stability; (g) an evaluation of PREPA's existing resources including those in private hands; (h) an evaluation of the system's environmental impacts including climate change; (i) an evaluation of the interconnection of renewable energy, DG and independent power producers; (j) projections with regards to the integration of DG into the electric power grid; (k) Identification of essential service facilities across the Island and the measures to be implemented to render the electric power service delivered to such facilities more resilient, such as the establishment of microgrids, DG, and underground distribution lines; (l) an evaluation of the necessary actions to achieve the energy storage system goals; and, (m) any other requirement established by the Energy Bureau through regulations or order.[65]

E. Background and Context of Changes since 2015 IRP

1. Regulatory Background- final IRP Rules, Regulation 9021

149. This Final Resolution and Order is based on Regulation 9021, and PREPA's compliance with its requirements and the goals and objectives of the Legislature. The content and purpose of these regulations have been discussed above in Parts (C)(1) and (D). This IRP proceeding is the first under Regulation 9021, but it is not occurring under ordinary circumstances given the ravages of Hurricane María, a subsequent earthquake, a bankrupt utility, and continued economic challenges in Puerto Rico. These circumstances require careful evaluation and are unique from those encountered in a typical IRP proceeding, and are discussed below.

2. Technological and economic change (costs of resources)

150. The cost of renewable energy generation technology (in particular of solar photovoltaic technology, but also applicable for wind generation technologies, both onshore and offshore) and of battery energy storage has fallen substantially within the period between the 2015 IRP and this proceeding. In the 2015 IRP, PREPA assumed that solar

[64] *Id.* at § 1.9(2).

[65] *Id.* at § 1.9(3).

NEGOCIADO DE ENERGÍA NEPR DE PUERTO RICO JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

PV would cost $130/MWh if installed in 2021.[66] In contrast, in this IRP PREPA assumes the same 2021 solar PV would cost $64/MWh.[67] Similarly, the 2015 IRP did not consider battery energy storage as an explicit resource category,[68] whereas the Proposed IRP includes more than 900 MW of energy storage by 2025 in every modeled case as part of least cost models.[69] These changes stand in stark contrast to relatively limited changes in either the technology or the costs of more conventional fossil-fueled supply resources.

3. Demographic changes affecting the IRP (load forecast)

151. The electric load in Puerto Rico has been declining for years given lost manufacturing and residents leaving the Island to move elsewhere. This decline has created a number of challenges. The Legislature summed up the situation when it stated:

> …over the past 10 years, the Island's energy demand has decreased by 18% and the industrial sector's energy demand has decreased by 48%. In addition, the main generation units are located in the south while the highest energy demand is in the north. Moreover, our electric power generation system is twenty-eight (28) years older than the electric power industry average in the United States and our oil dependence renders this system increasingly more expensive, more polluting, and less efficient.[70]

152. PREPA's load forecast in the Proposed IRP shows continued reduction in energy demand, projecting a compound annual growth rate of -0.23% over the analysis period.[71] This forecast reflects the Puerto Rico Financial Oversight and Management Board (FOMB) projections of relatively flat real gross national product (GNP)[72] and falling population[73] through 2038.

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[66] Final Order and Resolution, In Re: Integrated Resource Plan of the Puerto Rico Electric Power Authority, Case No. CEPR-AP-2015-0002, September 23, 2016, paragraph 186.

[67] *See* Proposed IRP, Exhibit 6-31, page 6-23.

[68] Final Order and Resolution, In Re: Integrated Resource Plan of the Puerto Rico Electric Power Authority, Case No. CEPR-AP-2015-0002, September 23, 2016, paragraph 196.

[69] *See* Proposed IRP, Exhibit 1-7 on pages 1-14 and 1-15.

[70] *See* Act 120, Statement of Motives.

[71] *See* Proposed IRP, Exhibit 3-10, page 3-10.

[72] *Id.*, Exhibit 3-7 at page 3-8.

[73] *Id.*, Exhibit 3-8 at page 3-8.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

4. Exogenous impacts on the IRP

153. Given the severe economic condition of PREPA with a $9 billion bankruptcy filing and a total lack of public confidence in its ability to properly operate an efficient electric system, Act 120 was enacted to establish the legal framework for the sale, disposition and/or transfer of operations, functions, and services of PREPA through one, or multiple transactions. The Legislature defined the PREPA Transaction[74] for the transition of the Island's government operated electric ecosystem to a system operated in a public private partnership with energy industry experts. That process is underway and when completed will result in a major shift in responsibilities, duties and obligations from public/government managed to privately operated/managed.

154. Moreover, the major destruction of the T&D system by Hurricane María and the recent crippling of the Costa Sur generation units as a result of a series of earthquakes that impacted the island early in 2020 have resulted in the need for a substantial evaluation of the electric system, to define what can be done most cost-effectively to revamp the island's energy infrastructure and what sources of funding are available through the Federal Emergency Management Agency (FEMA) and elsewhere for such purposes.

155. The Energy Bureau is mindful of these circumstances, and cognizant of its role in the full and transparent implementation of the energy reform on the Island. The Energy Bureau is proceeding now to make sure that PREPA is moving in the right direction consistent with the energy public policy of the Government of Puerto Rico. Being proactive now will help ensure that Puerto Rico's energy system is incorporating least cost resource options that will bring energy costs down and help the economy of the Island. Acting now will also ensure that the future operator(s) of the electric system will be handed a better-positioned electric system to operate. With this in mind, the Energy Bureau has focused on the future electric system planning needs in its review and decisions in this IRP proceeding.

5. Physical and electrical effects of the hurricanes and earthquake on resilience.

156. The September 2017 hurricanes and the January 2020 earthquakes have all taken a significant toll on Puerto Rico's electric system, highlighting the need to rebuild a more resilient system. Legislation passed after the hurricanes stresses the importance of building a stronger grid.[75] The hurricanes ripped through Puerto Rico taking out much of the T&D system, making it impossible to deliver electricity generated in the southern portion of the Island to the northern population centers. The earthquake then took down the Costa Sur units which, while slated for retirement in the next few years, nevertheless provided a significant amount of electricity. The Legislature has already

[74] *See* Act 120§ 2(l); see also §I(B)(4) above.

[75] *See* Act 17 and Act 120.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

stressed the need to decentralize generation in Puerto Rico. This direction has a number of benefits: smaller units can be located closer to load and can make communities less dependent on long transmission lines crossing the Island; a system of smaller, distributed units can help reduce the level of reserve needed in that the system must maintain reserve comparable to the capacity of its largest generating unit and smaller units can allow the retirement of, or reduce the utilization of, Puerto Rico's largest units; moreover, these smaller decentralized units often rely on renewable energy, thereby reducing pollution and reducing costs. All of these factors are taken into consideration when planning for a modern electricity system that is resilient, efficient, least-cost and less impactful on the environment.

F. Summary of Energy Bureau Process

157. Regulation 9021 sets forth the legal process to be used in the IRP proceeding.[76] In terms of process, the most significant difference between Regulation 9021 and Regulation 8594, which was used in the 2015 IRP, was the creation of a Phase 1 process that enabled the Energy Bureau to signal to PREPA any necessary course corrections in the development of the IRP so that it conformed with Puerto Rico Laws and Energy Bureau Regulations. This process also created public involvement and transparency and led to a Proposed IRP filing that needed less revisions prior to being accepted than the 2015 IRP. The new process also resulted in a smaller number of delays.[77]

158. Once PREPA's IRP filing was accepted by the Energy Bureau with requirements to file additional information, the Energy Bureau began a thorough and detailed review of the filing. The Energy Bureau submitted to PREPA ten rounds of Requirements of Information (ROI), each of which included lists of questions, data requests and instructions for PREPA to conduct various modeling runs that it had not included in its Proposed IRP filing. The purpose of the modeling runs was to test need and cost-effectiveness outcomes assuming higher levels of renewable and demand-side options, or other variations in input assumptions to examine the robustness of model results. PREPA issued ROIs to intervenors who also provided both comments and testimony. The participation of intervenors and *amici curiae* was extremely valuable as their input provided additional perspectives and information for the Energy Bureau's consideration.[78] The intervenors were provided a full opportunity to participate in the

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[76] *See* Regulation 9021, Article III.

[77] For more details on the process, see "Appendix A -: Timeline and History of the Proceeding of this Final Resolution and Order.

[78] The Energy Bureau granted intervention status for eighteen (18) intervenors: the Environmental Defense Fund; Sunrun, Inc.; Local Environmental Organizations (Comité de Dialogo Ambiental, Inc. El Puente Williamsburg, Inc. - Enlace Latino de Acción Climática, Comite Yabucoefio Pro-Calidad de Vida, Inc., Alianza, Comunitaria Ambientalista del Sureste, Inc., Sierra Club and its Puerto Rico Chapter, Mayagüezanos par la Salud

hearing and provided Briefs and Reply Briefs, all of which were considered in the Energy Bureau's deliberations. The Energy Bureau also sought public comment on the IRP and held five (5) Public Hearings in various locations throughout Puerto Rico.[79]

159. The Energy Bureau's decisions and orders summarized above and discussed below are based on a complete and transparent process, with the full participation of many intervenors and the general public, and after a careful analysis and investigation into the substance of the Proposed IRP filing PREPA Application and a review of the evidence in the record as applied to the laws and regulations of Puerto Rico.

II. PREPA APPLICATION

A. Overview of PREPA's Approach

160. PREPA's Proposed IRP is intended to inform the transformation of Puerto Rico's electricity supply portfolio, along with associated changes in T&D infrastructure.[80]

161. The IRP should reflect changes in Puerto Rico's public policy (notably the obligations to substantially reduce energy supply costs and plan to meet the revised renewable portfolio standard); address the reliability, environmental, and cost impacts of an aging and largely oil-fired generation fleet; and incorporate the lessons and impacts of

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y el Ambiente, Inc., Coalición de Organizaciónes AntiIncineracion, Inc. Amigos del Rio Guaynabo, Inc. Campamento Contra las Cenizas de Peñiuelas, Inc. and CAMBIO Puerto Rico); EcoEléctrica, L.P.; Grupo WindMar; Independent Consumer Protection Office (OIPC); Empire Gas Company, Inc.; AES Puerto Rico, LP; National Public Finance Guarantee Corp.; Progression Energy; Shell NA LNG LLC; Wärtsilä North America; Non Profit Intervenors (Centro Unido de Detallistas (CUD); Cámara de Mercadeo, Industria y Distribución de Alimentos (MIDA); Puerto Rico Manufactures Association (PRMA); Cooperativa de Seguros Múltiples de Puerto Rico (CSMPR), Unidos Por Utuado (UPA), and el Instituto de Competitividad y Sostenibilidad Económica de Puerto Rico (ICSE-PR)); Caribe GE International Energy Services, Corp.; Solar and Energy Storage Association of Puerto Rico; League of Cooperatives of Puerto Rico and AMANESER 2025, Inc; and Arctas Capital Group, LP. The *Amici Curiae* filings were presented by the Rocky Mountain Institute (RMI), la Asociación de Consultores y Contratistas de Energía Renovable de Puerto Rico, Inc. (ACONER); and el Colegio de Ingenieros y Agrimensores de Puerto Rico (CIAPR).

[79] San Juan, Arecibo, Humacao, Mayagüez, and Ponce, See Appendix B: Summary of Public Comments for more details.

[80] PREPA's IRP preparation process was led by consultants from Siemens PTI. In his testimony, PREPA Executive Director José Ortiz states that "[t]he IRP was prepared by PREPA's consultants from Siemens Power Technologies International (Siemens), working closely with PREPA personnel supported by advisors from Filsinger Energy Partners." During the discovery process and technical hearings, many answers to Energy Bureau's ROIs and other questions came from employees of Siemens or Filsinger Energy Partners (FEP). PREPA presented Siemens's and FEP's experts as its witnesses at the Evidentiary Hearing. PREPA bears the full responsibility for the entire contents of its IRP, regardless of which entity was responsible for specific assumptions, methods employed, findings or recommendations. This Final Resolution and Order refers exclusively to PREPA as the author and proponent of the IRP and all ROI responses.

Hurricanes Irma and María and their aftermath. PREPA states that the IRP is "fully aligned with the five key pillars adopted by the PREPA Governing Board in its Vision for the Future of Power in Puerto Rico."[81] These five pillars are: (1) customer-centric; (2) financial viability; (3) reliable and resilient; (4) model of sustainability; and (5) economic growth engine.

162. The structure of PREPA's filed IRP generally follows the structure laid out in the Energy Bureau's Regulation 9021.[82] PREPA developed assumptions for input parameters such as the load forecast and the capital and operating costs and availability of different new generation and energy storage options, as well as the characteristics of existing generators. PREPA identified potential scenarios and strategies and developed optimized supply portfolios within numerous cases using capacity expansion modeling. PREPA then considered the results of these cases to develop a Preferred Resource Plan, taking into account both the cost to ratepayers and other evaluation metrics. PREPA then described an Action Plan that lays out specific actions and approaches to take during the next five years.

163. Notwithstanding the above, PREPA's IRP is unusual in several respects. First, it is conducted in the context of declining load. Even before incorporating the impacts of EE and DG, projections of Puerto Rico's falling population and slow economic growth lead to projections of declining load. Second, the impacts of Hurricanes Irma and María have led PREPA to propose a fundamental change in the geographic configuration of its generation fleet, with generation moving closer to load. This shift led PREPA to include substantial changes in T&D in its IRP, rather than being solely or primarily concerned with generation. Third, changes in public policy regarding renewable electricity supply and EE mean that this IRP reflects a dramatically different policy context than the previous IRP, completed only three years ago.

B. Scenarios, Strategies, Sensitivities, and Nomenclature

1. Scenarios

a. Definitions

164. PREPA developed five Scenarios that reflect different levels of availability of natural gas imports and infrastructure, as well as solar PV and batteries. The Scenarios also reflect specific assumptions regarding the cost of renewables and storage.[83] PREPA recognized that the import of liquified natural gas into Puerto Rico and its use to fuel new or

[81] *See* Proposed IRP, page 1-1.

[82] *See* Regulation 9021, Regulation of the Integrated Resource Plan of the Puerto Rico Electric Power Authority, CEPR-MI-2018-0005, February 8, 2018.

[83] *See* Proposed IRP, page 1-3.

existing combined cycle and turbine generators could be part of a preferred resource plan. However, PREPA recognized that there is substantial uncertainty regarding the ability to develop and construct natural gas import facilities and generators in different parts of the island. Another substantial source of uncertainty is the cost and availability of renewable generation (particularly solar PV) and battery storage. The five scenarios identified by PREPA are as follows:

- Scenario 1 - No new natural gas (gas) delivery infrastructure added, combined with reference (base case) cost and availability of renewable generation.
- Scenario 2 - Gas delivery is made available only in the north, combined with reference (base case) cost and availability of renewable generation.
- Scenario 3 - Gas is made available at multiple, new LNG terminals (north, east, and west locations), combined with further reduction in the cost of renewables and higher renewable resource (solar PV) availability.
- Scenario 4 - Gas is made available at multiple, new LNG terminals (north, east, and west locations), combined with reference (base case) cost and availability of renewable generation.
- ESM - a variant on Scenario 4 with several fixed decisions, including new LNG in the north, east, and west, discussed in more detail below.
- Scenario 5 - Similar to Scenario 4, but with the Aguirre Offshore Gas Port (AOGP) as an option, and larger combined cycle units also available for selection.

165. These scenarios will be discussed in more detail below. Resource availability and costs in each Scenario are summarized in the following table:[84]

Table 1. Resource Scenario Definition

Scenario	New Gas				Renewable & Storage	
	AOGP	Land-based LNG at San Juan	Ship-based LNG at Yabucoa	Ship-based LNG at Mayagüez	Costs	Availability
1	No	No	No	No	Reference	Reference
2	No	Yes	No	No	Reference	Reference
3	No	Yes	Yes	Yes	Low	High
4	No	Yes	Yes	Yes	Reference	Reference
5	Yes	Yes	Yes	Yes	Reference	Reference
ESM	No	Yes	Yes	Yes	Reference	Reference

[84] *See* Proposed IRP, Exhibit 5-2, page 5-5.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

166. In conducting capacity expansion modeling, PREPA noted that Scenario 4 cases generally do not select resources located in the west (Mayagüez) or east (Yabucoa). Scenario 4 cases therefore also meet the definition of Scenario 2. As a result, PREPA noted that it dropped Scenario 2.[85]

b. ESM Scenario

167. Among the scenarios it developed, PREPA chose the ESM Scenario as its Preferred Resource Plan in the Proposed IRP. This scenario has many features in common with Scenario 4. In the ESM Scenario, PREPA sets as fixed, several decisions that differ from Scenario 4, and then evaluates the resulting impact on system cost. PREPA states that these fixed decisions are intended to reflect those projects that PREPA and its team of experts determined to have the best chance of success. PREPA states: "The ESM was developed with projects that have a higher likelihood of achieving completion in the short-term because they have active proponents and are advantaged by the P3 procurement process."[86] The fixed decisions in the ESM Scenario are:

- Retain EcoEléctrica under the terms of a new contract;
- Replace all 18 existing Frame 5 (21 MW GTs, totaling 378 MW) at optimized locations with new mobile gas turbine units (23 MW each) or equivalent, to come online by 2021 and with containerized LNG as a fuel option (418 MW total);
- Develop an LNG terminal at Yabucoa and a 302 MW F-Class CCGT in June 2025;
- Develop an F-Class CCGT at Palo Seco by 2025 fueled by a land-based LNG at San Juan; and
- Develop a new ship-based LNG terminal at Mayagüez and convert, from diesel, to dual fuel, the Aero Mayagüez units (4 x 50 MW).87

2. Strategies

168. In the Proposed IRP, PREPA pairs each of the scenarios with one or more strategies. These strategies reflect different constraints regarding the extent to which generation resources must be located in geographic proximity to loads, and the maximum size of generation available. PREPA describes the strategies as follows:

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[85] *See* Proposed IRP, page 5-4.

[86] PREPA Workpaper, "Considerations on the ESM Plan." The P3 procurement process refers to the process by which the P3 has received solicited or unsolicited bids for new generation.

[87] *Id.* at page 2.

- Strategy 1 - Reflects a traditional, centralized energy program with generation resources predominately located at a few centralized locations emphasizing reliability and economic metrics.
- Strategy 2 - Reflects a system of more distributed, flexible generation, emphasizing resiliency and closer proximity of generation sources to the customer. This strategy incorporates micro or MiniGrids and hardening of existing PREPA infrastructure. In this strategy, most of the load is supplied from local supply resources that can be isolated from the remainder of the grid during a major event, but still supply all or a portion of the nearby load.[88]
- Strategy 3 - Reflects a hybrid of the first two strategies that embodies a combination of the benefits of Strategy 1 and Strategy 2. In this strategy, economies of scale are considered, which results in some of the load potentially served, under normal conditions, from remote resources. During a major event, the potential for greater levels of rotating load shed in this strategy is greater than with Strategy 2 but should also result in lower operating costs.[89]

3. MiniGrids

169. In the Proposed IRP, PREPA proposes to develop and redesign its combined transmission, distribution, and generation system into eight functional areas, referred to as "MiniGrids." The MiniGrids would operate during major events and emergencies, not during day-to-day operations of the grid. The functional infrastructure on the MiniGrids would enable the isolation of areas affected by major events from the remainder of the grid, preventing, to the extent possible, island wide blackouts." Each MiniGrid would be able to independently provide portions of the expected levels of electrical service, even if disconnected from the rest of the system in response to, or as a consequence of, a major event such as a hurricane. Within each MiniGrid, PREPA assumes that black-start-capable thermal generation would be required to meet "critical" loads – those "most necessary for the safety and health" – and other loads on the same feeders as the critical loads.[90] PREPA intends for critical loads to be able to regain service immediately following a major event. PREPA further assumes a need to restore service to "priority" loads – those required to regain normalcy and restart the economy – within a week of an event, and all service within one month.[91] PREPA assumes that priority loads would be met with renewable resources (primarily solar

[88] *See* Proposed IRP, pages 1-3 to 1-4.

[89] *Id.*

[90] *Id*. at page 1-8.

[91] *See* Proposed IRP, page 1-8; Appendix 1, page 2-5.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

PV) and batteries, to the extent they are not met with thermal resources located in the MiniGrid area.[92]

170. The local-generation requirements of the MiniGrid areas constrain the resource selections within PREPA's modeled portfolios under Strategies 2 and 3. PREPA defined Strategy 2 such that eighty percent (80%) of peak load must be able to be met with local resources (i.e. within the same MiniGrid), while in Strategy 3 only fifty percent (50%) must be able to be met with local resources.

4. Sensitivities

171. In addition to the Scenario/Strategy combinations, PREPA used Sensitivities to "isolate the impacts of certain important variables while holding other assumptions constant."[93] The variables tested via the sensitivity analysis reflect different kinds of uncertainty, primarily in the cost and availability of different resources. The sensitivities in PREPA's Proposed IRP are numbered 1 through 9:[94]

1. Deeper reduction in cost of solar and storage, coupled with high availability of storage and solar;
2. Lower EE penetration;
3. Economic retirement of AES and EcoEléctrica regardless of contract term;
4. Ship-based LNG at San Juan achieves permitting approval; reduces capacity in comparison to the land-based LNG option;
5. High gas prices;
6. High cost of solar and storage;
7. No San Juan 5 & 6 conversion to natural gas, applied to Scenario 1;
8. Base cost of renewable generation and storage, applied to Scenario 3; and
9. EcoEléctrica not forced to retire in order to identify in Scenario 4, the actual reduction in fixed payments that makes this case equivalent to the situation where EcoEléctrica is replaced by a new combined cycle generator at Costa Sur.[95]

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[92] *See* Proposed IRP, Appendix 1, page 2-7.

[93] *See* Proposed IRP, pages 5-6 to 5-7.

[94] PREPA analyzed and filed additional sensitivities as part of the Requirement of Information process that were not part of the original IRP filing. These additional sensitivities are discussed in Section 2.4 below, and include: sensitivity 10 (reflecting a "carbon adder", PREPA's Response to Question 6 of the Energy Bureau's Sixth Requirement of Information, September 27, 2019); sensitivity 11 (reflecting a "delayed solar" installation case, *id.,* question 4*;* and, sensitivities 12 and 13 (reflecting "high" and "low" LNG infrastructure costs, *id*., questions 5 and 6 respectively).

[95] *See* Proposed IRP, pages 5-6 to 5-7.

172. PREPA further developed High, Base, and Low load forecasts. These forecasts are not treated as sensitivities. Instead, they may be applied to any case.

5. Nomenclature

173. A given case modeled by PREPA is named based on the Scenario, Strategy, and Sensitivity that it reflects, in that order. High, Base, and Low load forecasts are labeled by the addition of the letter "H", "B", or "L" at the end of the case name. For example, case "S4S2S5B" is Scenario 4, Strategy 2, and Sensitivity 5 with the Base load forecast, while case "S3S2H" is Scenario 3, Strategy 2, with a high load forecast.

C. Modeling

174. PREPA used the Aurora long-term capacity expansion (LTCE) model to evaluate the costs of each considered case.[96] The Aurora model seeks to minimize the present value of revenue requirements for PREPA within the constraints set for each case, while maintaining reliable levels of electric supply to meet load throughout the study period. PREPA modeled through the end of 2038, representing a 20-year span from the beginning of 2019. PREPA conducted further "nodal" analysis to evaluate how the configuration and capabilities of PREPA's transmission system impact congestion, technical losses, production costs, renewable curtailment, and energy not served.[97]

175. In order to conduct its modeling, PREPA developed assumptions regarding numerous input factors, such as:

- the load forecast before and after the effect of EE programs and policies;[98]
- the capital cost and availability in Puerto Rico of energy storage and both thermal and renewable resources;[99]
- the performance of different generating technologies in the Puerto Rico context;[100] and
- and the fuel costs for natural gas, oil, and propane, delivered to Puerto Rico.[101]

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96 *See* Proposed IRP, page 2-4.

97 *See* Proposed IRP, page 8-42.

98 *See* Proposed IRP, Section 3.

99 *See* Proposed IRP, Section 6.

100 *Id.*

101 *See* Proposed IRP, Sections 7.1 and 7.2.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

176. PREPA also developed other assumptions, such as the extent of DG deployment,[102] the pace at which solar PV and battery energy storage systems (BESS) resources can be procured and interconnected,[103] and the approximate locations for new thermal generating facilities.[104]

177. In its MiniGrid proposal, PREPA assumes a certain target level of resilience and, implicitly, a frequency for major storms to justify the need for resilience investment. PREPA also assumes a set of critical and priority loads in each MiniGrid and that only thermal resources are available in the immediate aftermath of an event and are thus required to meet critical loads. Moreover, PREPA assumes a need to harden specific transmission infrastructure to support critical loads and all other loads that share feeders with critical loads. PREPA implicitly assumes a tradeoff between hardened T&D infrastructure and on-site microgrids for critical and priority loads that are farther from existing or proposed thermal generation.[105]

D. Supplemental Analysis in Responses to Requirements of Information and Requests of Information

178. In addition to the core set of cases described in PREPA's Proposed IRP, PREPA conducted numerous additional modeling analyses in response to Requirements of Information (ROI). These additional modeling runs are part of the Administrative Record of this proceeding. Therefore, they inform the Energy Bureau's decision-making regarding the Proposed IRP. The additional modeling runs are described below.

1. Energy Bureau's Orders Regarding AES Fuel Conversion

179. On April 26 and May 23, 2019, the Energy Bureau issued Resolution and Orders requiring (and then clarifying) that PREPA must model and submit the results of cases in which the AES coal-fueled electric generation facility is converted to natural gas at the start of the modeling period (*i.e.*, FY-20).[106] While these Resolution and Orders were issued during Phase I (*i.e.*, before the Proposed IRP was filed), the results of the AES analysis were not available to include in the Proposed IRP. Instead, PREPA filed the results on August 23, 2019.

[102] *See* Proposed IRP, Appendix 4, Section 3.

[103] *See* Proposed IRP, page 6-22.

[104] *See* Proposed IRP, pages 7-6 to 7-18.

[105] *See* Proposed IRP, Appendix 1, Section 2.

[106] Resolution and Order*,* In Re: Review of the Puerto Rico Electric Power Authority Integrated Resource Plan, Case. No. CEPR-AP-2018-0001, April 26, 2019, page 5-6.

2. Energy Bureau-PREPA ROI 6

180. In its sixth set of ROIs, the Energy Bureau required PREPA to provide the results of modeling for additional combinations of cases and sensitivities, with LTCE runs as necessary. [107] These include:

- high and low load and high and base renewable cost sensitivities to S3S2;
- a new sensitivity (Sensitivity 10) with a carbon price adder to S4S2B, S3S2B, and ESM (baseload) based on the "consensus forecast" carbon price reflected in Exhibit 4-27 of the IRP;
- a new sensitivity (Sensitivity 11) that delays early-year installations of solar PV in S3S2 to align with those seen in S4S2 through 2025, and allocates the delayed solar to the period between 2026 and 2030;
- a new sensitivity (Sensitivity 12) to test the impact of high cost for gas infrastructure on S4S2 and ESM; and
- a new sensitivity (Sensitivity 13) to test the impact of low cost for gas infrastructure on S4S2 and ESM.

3. Energy Bureau-PREPA ROI 7

181. In its seventh set of ROIs, the Energy Bureau required PREPA to provide the results of modeling for additional cases, with LTCE runs as necessary.[108] These include:

- an ESM case with updated pricing for natural gas at San Juan 5 & 6;
- a version of each of S4S2B and S3S2B with no limitations on solar PV and BESS installations starting in 2022; and
- results of S4S1H and S4S1L (Strategy 1 with high and low load).

4. Energy Bureau-PREPA ROI 9

182. In its ninth set of ROIs, the Energy Bureau required PREPA to provide the results of additional cases, with LTCE runs.[109] In particular, the Energy Bureau provided load projections corresponding to a Low Energy Efficiency (Low EE) case and a No Energy Efficiency (No EE) case. The Energy Bureau required PREPA to model the equivalent to cases S1S2, S3S2, S3S2S8, S4S2, and S5S1 with these load forecasts, with the option also to provide an ESM case. The Energy Bureau further required PREPA to submit the results of several runs in order to correct errors that the Energy Bureau identified in

[107] Energy Bureau-PREPA ROI 6, September 6, 2019; PREPA responded in parts on September 27 and October 4, 15, and 18, 2019.

[108] PREPA's Responses to Energy Bureau's ROI 7, September 27 and October 4, 2019.

[109] PREPA's Responses to Energy Bureau's ROI 9, November 27, 2019 (supplemented on December 6, 2019, and further revised its response on March 2, 2020).

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

the implementation of Sensitivity 8, including reference storage prices in addition to reference solar PV prices, gas peaker costs, and wind resource costs. PREPA was required to provide an assessment of how the proposed Action Plan would change under the No EE and Low EE load cases.

5. AES-PR-PREPA ROI 1

183. In its first Request of Information, AES-PR requested the results of additional LTCE modeling runs. [110] After further consultation, AES-PR and PREPA agreed to a set of six LTCE runs. Four runs model cases in which AES-PR stops burning coal at the end of 2020[111] and two cases that model gas conversion after the end of AES-PR's current contract in 2027. Each pair of runs was conducted with the baseload forecast and the Low EE load forecast defined in PREB ROI 9.

6. Energy Bureau-PREPA ROI 10

184. In its tenth set of ROIs, the Energy Bureau required PREPA to provide the results of additional cases, primarily regarding the impact of specific terms for a proposed contract between EcoEléctrica and PREPA.[112] The cases modeled are: (1) No EE and Low EE versions of S1S2, S3S2, S4S2, and S5S1; (2) S4S2B and S3S2B; and (3) No EE and Low EE versions of the no-limitation solar and BESS case examined in ROI 7-2.

III. ANALYSIS AND FINDINGS BY TOPIC AREA

A. Load Forecast

185. Section 2.03 (C) of Regulation 9021 requires that "PREPA shall present a forecast of future capacity and energy demand requirements, as well as an analysis of prior load forecasts." Further, Regulation 9021 establishes the requirements for load forecast documentation[113] and load forecast analysis.[114] Regulation 9021 also requires PREPA to prepare three baseline load forecasts that, "…reflect a reasonable range of future uncertainties."[115]

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[110] PREPA's Responses to Energy Bureau's ROI 1, November 27, 2019 (supplemented on December 6, 2019).

[111] Two of these cases model conversion to natural gas of the AES-PR plant, while the other two close the plant without conversion.

[112] PREPA's Responses to Energy Bureau's ROI 10, January 22, 2020.

[113] *See* Regulation 9021, § 2.03(C)(1).

[114] *Id.* at § 2.03(C)(2).

[115] *Id.*

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

186. In Part 2 of the Proposed IRP (Planning Environment), PREPA acknowledges the difficult planning environment within Puerto Rico, including key factors impacting system load such as economic output and population. Prior to the 2017 hurricanes, the Puerto Rican economy had been in structural decline with annual decreases in both GNP and population of at least one percent per year.[116] These trends were exacerbated by the 2017 hurricanes, including a four percent (4%) decline in population due to migration and loss of life and a major contraction of economic activity.[117] These and other factors, including the mandate to pursue EE and the rapid cost declines in distributed energy resources, are projected to result in significant decreases in system load over the Proposed IRP planning horizon. To that effect, PREPA states in the Proposed IRP that "declining load growth presents a difficult planning environment that requires PREPA to preserve optionality to develop new resilient resources should load growth be higher than forecast."[118]

1. PREPA Filing

187. Part 3 of the Proposed IRP provides historical load data, description of load forecasting methodology, and load forecasts. Load forecasts for the 20-year IRP planning horizon include a base, low, and high forecast.

188. PREPA reports in the Proposed IRP that net generation in Puerto Rico declined from 23,720 gigawatt-hours (GWh) in 2007 to 16,789 GWh in 2018.[119] During the same timeframe, peak demand declined from 3,546 MW to 2,705 MW.[120] The industrial sector experienced the largest decline in sales at forty-seven percent (47%) from FY2007 to FY2017.[121] Over the same timeframe, residential sales and commercial sales of electricity declined by twelve percent (12%) and ten percent (10%), respectively.[122] PREPA attributes the decade-long decline in sales to the seventeen percent (17%) decline in Puerto Rico's GNP and fifteen percent (15%) decline in population from 2007 to 2017.[123]

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[116] *See* Proposed IRP, page 3-6.

[117] *Id.*

[118] *See* Proposed IRP, page 2-7.

[119] *Id.* Exhibit 3-3 at page 3-3.

[120] *Id.*

[121] *See* Proposed IRP, page 3-1.

[122] *Id.*

[123] *Id.*

a. Load forecast methodology

189. The load forecast that PREPA relied upon in the Proposed IRP was developed using customer class-specific, statistical and econometric time-series models to determine forecasted monthly energy sales for each of the three primary customer classes: residential, commercial, and industrial. PREPA developed a linear regression model, with energy sales as the dependent variable and fifteen (15) independent variables.[124] The independent variables used in the regression were a weather variable in the form of cooling degree days (CDD), two economic variables (population and GNP), and dummy variables for each month. The population variable was not statistically significant in the regression model for the industrial sector, thus PREPA substituted it with manufacturing employment.[125]

190. PREPA states in the Proposed IRP that the independent variables for the commercial load forecast do not include population. However, the load forecast workpaper shows that population is used, but that GNP is not used. PREPA provides no explanation for why the commercial load forecast uses fewer independent variables.

191. PREPA used the statistical software tool MATLAB to perform an ordinary least-squares regression technique. The regression model had robust statistical significance, with p-values less than 0.01 for all of the economic and weather-related independent variables (that is, for all but the monthly dummy variables). The adjusted r-squares of the regressions were 0.82, 0.58, and 0.96 for the residential, commercial, and industrial sectors respectively.[126] The commercial sector regression is discussed in more detail in the Discussion Part below.

192. PREPA used the coefficients derived from the regression equations to create the baseload forecast. This required data on the independent variables used to develop the regression equation. PREPA used historical monthly data from the National Oceanic Atmospheric Administration (NOAA) from 2000 to 2016 to develop expected monthly cooling degree days under normal weather conditions for use in the model.[127] PREPA utilized GNP and population projections from the FOMB in the regression model to produce the baseload forecast.[128] Over the IRP planning horizon, the FOMB projects population declines at 1.3% per year. FOMB projects GDP to increase rapidly initially in response to relief efforts after the 2017 hurricanes and then moderate to annual

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[124] *Id*. at page 3-3.

[125] *Id*.

[126] Load forecast methodology results are found in workpaper Step2_PREPA_Econometric_ModelDev_smooth_final.xls. "R-square" is a statistical test that evaluates how much of the variation in one (dependent) variable is explained by the variation in the input (independent) variables. A R-square of 1.0 is a perfect fit, while 0.0 indicates no relation.

[127] *See* Proposed IRP, pages 3-6 to 3-7.

[128] *Id*. at page 3-7.

increases of 1.6% through 2027. After 2027, the FOMB projects annual growth rates of -0.3%.

193. The IRP's gross long-term energy forecast (i.e., without consideration of the impact of EE, DR, and DG) results in a compound annual growth rate (CAGR) in total sales of -0.23%.[129] Thus, PREPA's long-term gross energy forecast finds a continuation of the historical trend of declining energy sales. Energy sales to all sectors are forecast to decline except for the industrial sector (with a projected CAGR of 1.38%). PREPA forecasts residential energy sales to have a larger decline than the other sectors, with a CAGR of -0.61%.

194. PREPA's gross load forecast is based on the observed historical relationship between energy consumption and drivers such as economic activity and population. As a result, it includes the pace of naturally occurring increases in EE and energy productivity that have occurred in the past. It does not include the impacts of any Federal appliance standards or any other policy or regulation that changes the pace of natural EE improvement from its historical rate. Such new policies and their potential effects are addressed in Part III(B) of this Final Resolution and Order.

195. PREPA presents a forecast of gross energy demand for generation, inclusive of auxiliary loads, technical and non-technical losses, and PREPA's own use. PREPA assumes that annual use for auxiliary loads and PREPA's own use remain constant over the IRP planning horizon. PREPA assumes that the sum of the technical and nontechnical losses will remain at a constant percentage of total energy demand over the planning horizon, at twelve percent (12%). After accounting for these factors, PREPA projects gross energy generation to decline from 18,351 GWh in 2019 to 17,608 GWh in 2038, representing a -0.22% CAGR.[130]

196. To forecast peak demand for energy, PREPA used constant customer class load factors and customer class coincident factors. PREPA forecast the demand at the time of system peak using these values and the forecasted energy consumption by customer class. Several factors were used to adjust these peak load estimates to account for technical and non-technical losses, PREPA's own consumption, and the effects of consumption on the generating plants' auxiliary services. PREPA forecasts the gross peak demand (prior to accounting for EE, DR, or DG) to decline from 2,791 GW in 2019 to 2,666 GW in 2038, representing a CAGR of -0.24%.[131]

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[129] *See* Proposed IRP, Exhibit 3-10, page 3-10. This contains the total sales forecast as well as the sector-specific forecasts.

[130] *See* Proposed IRP, Exhibit 3-11, page 3-11.

[131] *Id*. at Exhibit 3-24.

b. Analysis of high and low load forecasts

197. In developing high and low load forecasts, the IRP uses random sampling techniques to explore a range of possible future load trajectories.[132] The statistical method resulted in 2,000 unique distributions based on three independent random paths for CDD, GNP, and a residual variable. PREPA further added additional variability to represent future uncertainties not captured by historical data.[133] Based on PREPA's assessment of the results of the 2,000 stochastic distributions, they chose to use the 25th percentile as the low case and the 85th percentile as the high case.[134]

198. Exhibit 3-32 in the IRP presents the low and high gross sales forecast scenarios.[135] The high and low scenarios result in CAGRs of 0.34% and -0.57% over the IRP planning horizon, respectively. In the low load forecast, peak demand falls with a CAGR of -0.57%, the same rate as the energy forecast,[136] while in the high demand case it rises at a CAGR of 0.31%.[137]

c. Electric vehicles

199. PREPA did not include an explicit transportation-sector energy or peak load impact from EVs. In response to Energy Bureau-PREPA ROI 01-18(g), PREPA provided an assessment of the potential impact of electric vehicles on energy demand. PREPA developed forecasts of energy sales due to electric vehicle charging under cases modeled on EV penetrations in several US states (*e.g.*, California, Hawaii, and West Virginia) and the US average. PREPA based these EV adoption rates on "total light duty vehicles registered in Puerto Rico and different paths of forecast penetration nationwide."[138] The resulting energy sales due to EVs in 2038 range from 82 GWh per year to 226 GWh per year. These sales would represent roughly between 0.9% and 2.5% of the load forecast, after accounting for EE and DG. To reach these levels of electric sales, PREPA assumed an EV stock of between 38,359 and 105,508 vehicles in 2038. At the evidentiary hearing, Dr. Bacalao stated that these projections were small compared to the different load forecasts used in the IRP, and he therefore felt

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[132] *See* Proposed IRP, page 3-24.

[133] *Id.*

[134] *Id.* at page 3-26.

[135] *Id.* at page 3-29.

[136] Workpaper, "Load Forecast by Region PREPA EE_DG_2018 IRP Low Case35 pct EE 050319.xls"

[137] Workpaper, "Load Forecast by Region PREPA EE_DG_2018 IRP High Case35 pct EE 050319.xls"

[138] PREPA response to Energy Bureau's ROI 1, 18(g), page 17, August 2, 2019.

comfortable leaving the EV projection out of the load forecast for the purposes of planning.[139]

d. Effect of energy efficiency on forecast

200. The IRP evaluates the costs and other impacts of meeting the gross load forecast with a mix of utility-supplied energy resources, customer-sited and other DG, and EE. The multiple EE portfolios and resulting savings are addressed in Part III(B) of this Final Resolution and Order.

2. Intervenors

a. Environmental Defense Fund

201. In her expert testimony on behalf of Environmental Defense Fund (EDF), Dr. Elizabeth Stanton states that omitting EVs from the load forecast results in an underestimate of future energy demand.[140] At the evidentiary hearing, Dr. Stanton testified that PREPA's most ambitious scenario for EV adoption in Puerto Rico fell far below those contemplated by the high EV penetration scenarios in comparable IRPs in other jurisdictions.[141]

202. In its Final Brief, EDF states concern that PREPA is basing its decrease in load forecast on assumed growth in DG, without any incentives or market mechanisms to incentivize that trend.[142] EDF further criticizes PREPA for not including the load growth from electric vehicles.[143]

b. Independent Consumer Protection Office

203. In his expert testimony on behalf of the b. Independent Consumer Protection Office (ICPO), Mr. Gerardo Cosme Nuñez emphasizes the importance of the load forecast to the IRP and the uncertainty in the load forecast due to numerous factors such as the economic situation, technological change, the use of distributed energy resources, and EE.[144] He further testifies that customers' energy behavior and preferences should be taken into account in the load forecast.[145] Mr. Cosme states that in the face of

[139] Evidentiary Hearing, February 4, 2020, morning session, 26:18.

[140] EDF, Testimony of Dr. Elizabeth Stanton, October 23, 2019, page 15.

[141] Evidentiary Hearing, February 4, 2020, morning session, 00:45:30.

[142] EDF, Final Brief, March 6, 2020, page 22.

[143] *Id.*

[144] ICPO, Testimony of Gerardo Cosme Nuñez, October 23, 2019, page 2.

[145] *Id.*

uncertainty, the Action Plan should be flexible but should be responsive to the actual load and cost and availability of different resources.[146] He recommends that the Energy Bureau monitor the actual state of load and costs in order to evaluate the need for facilities before authorizing them. [147]

c. Local environmental organizations

204. In their Final Brief, the local environmental organizations (LEOs) criticize PREPA for not including electric vehicles in the load forecast, and state that this omission represents a failure on PREPA's part to consider "changes in the energy market conditions" and "changes in technology" as required by Act 17, Section 1.2(p).[148]

d. Solar and Energy Storage Association of Puerto Rico

205. In his expert testimony on behalf of Solar and Energy Storage Association of Puerto Rico (SESA-PR) Mr. Patrick Wilson states that EV adoption projections should be included in the IRP.[149] Mr. Wilson notes that the IRP does not take into account EVs and EV charging stations in use in Puerto Rico today, and assumes no additional load from EVs over the next twenty (20) years.[150] He states that numerous studies project future load growth from electric vehicles and that major automakers are expressing plans to ramp up production of EVs.[151] He recommends that the IRP should consider demand curve projections made elsewhere on EVs and draw reasonable assumptions about the likely impact of EVs on load growth. Mr. Wilson supports the EV analysis presented by the Rocky Mountain Institute (RMI) in its September *Amicus Curiae* Brief.[152]

206. Mr. Wilson testifies that Siemens's projections for DG are unreasonable because they do not differ by scenario, do not reflect the value of Renewable Energy Credits (RECs) purchased from customers, inadequately reflect cost reductions from innovation, do not include impacts of aggregation with mutual benefits to the utility and customer, do not reflect financing options making DG available to more customers, the increased interest in and adoption of storage alongside DG, and further market innovation due to an open utility market. He recommends that a more in-depth analysis be completed

[146] *Id.* at page 3.

[147] *Id.* at page 4.

[148] LEOs, Final Brief, March 6, 2020, pages 29-30.

[149] SESA-PR, Testimony of Patrick J. Wilson, October 23, 2019, page 7.

[150] *Id.* at page 8.

[151] *Id.* at pages 8-9.

[152] *Id.* at page 10.

before the IRP is final, and suggests this analysis would indicate an increase in the adoption of DG beyond the projections included in the Proposed IRP draft.

e. Windmar

207. In his expert testimony, Mr. Víctor González states that electric vehicles could be a substantial new source of revenue for the grid and could be used to help the grid manage its peak loads. He further states that the electric car market is growing at an exponential rate, that EVs can provide power back to the grid, and that some utilities have developed special rates that are accelerating the market.[153] Mr. González recommends that the IRP should consider increasing EV sales.[154]

3. Amicus Curiae

a. ACONER

208. In its *Amicus Curiae* Brief, ACONER states that the demand forecast in the IRP should include two effects not included in PREPA's filing: the reduction in demand from the increasing adoption of renewable off-grid systems, and the increase in demand from electric vehicles.[155]

b. Rocky Mountain Institute

209. In its Amended *Amicus Curiae* Brief, RMI states a concern that the demand forecast is uncertain and omits important factors.[156] In particular, RMI is concerned that the Preferred Resource Plan (ESM) is less robust to conditions with higher load than alternative plans. RMI presents results of an analysis of the potential load impact of electric vehicle adoption.[157] RMI concludes that adoption of EVs at the level of 15%, 30% and 50% of the vehicle stock would increase annual electric sales by 692 GWh, 1,384 GWh, or 2,306 GWh respectively. Relative to the base case 2038 electric sales under PREPA's load forecast, these increases would correspond to a 10%, 20%, or 33% electric sales increase, respectively. According to RMI, "[t]his analysis assumes a 2038 Puerto Rico population of 2.4 million and assumes driving behavior is comparable to

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153 Windmar, Testimony of Víctor González, October 23, 2019, pages 4-5.

154 *Id.* at page 5.

155 ACONER, *Amicus Curiae* Brief, March 6, 2019, page 4.

156 RMI, Amended *Amicus Curiae* Brief, December 20, 2019, page 7.

157 *Id.* at page 7-8.

that reported for Hawaii, i.e., that there are 0.93 vehicles per capita and that 8,231 miles are driven annually per vehicle."[158]

4. Discussion

210. PREPA's Proposed IRP met the requirements of Section 2.03 (C) of Regulation 9021 regarding the load forecast. Specifically, Section 3 of the Proposed IRP contains the following:

- historical data over 10-years of annual electricity generation and sales for the utility and consumption by customer class;
- the application of an industry-accepted methodology to forecast energy consumption by customer class and system peak demand that includes the effects of economic factors on electricity consumption;
- forecast of energy production and use over a 20-year planning horizon for each customer class;
- forecast of peak energy demand over a 20-year planning horizon;
- both energy consumption and peak demand forecasts net of the impacts of EE and customer owned DG and combined heat and power; and
- reasonable alternative scenarios in the form of a low and high trajectories that account for risks and uncertainties associated with weather and economic activity on the Island.

211. The impact of Hurricanes Irma and María resulted in "sudden and unexpected changes in Puerto Rico's energy system."[159] PREPA requested[160], and the Energy Bureau granted[161], a waiver to the requirement of Section 2.03 (C)(1)(e) to provide an assessment of the prior load forecast in the IRP.

212. PREPA projects electric energy use in Puerto Rico under a range of alternatives to decline over the 20-year IRP planning horizon. Given the historical trends of declining consumption and the potential for cost-effective EE and declining DG costs, it is reasonable to conclude as a baseline condition (*e.g.*, before the application of public policies for EE) that energy consumption on the Island will continue the historical trend of declining consumption in the foreseeable future.

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[158] *Id.* at page 8.

[159] PREPA's Motion for Limited Waivers of Filing Requirements Under Regulation No. 9021, February 13, 2019.

[160] *Id.*

[161] Resolution and Order, In Re: Review of the Puerto Rico Electric Power Authority Integrated Resource Plan, Case No. CEPR-AP-2018-0001, March 14, 2019, page 7.

213. PREPA's use of an econometric regression-based approach to develop the baseline load forecast is appropriate and aligned with Regulation 9021, which requires that "Load Forecasts shall be developed using methods that examine the effect of economic factors on electricity consumption…"[162] PREPA's use of population, gross domestic product, and manufacturing employment as the driving economic variables is reasonable and appropriate to the economic drivers of electric demand. The analysis also used normal weather conditions, as required by Regulation 9021, Section 2.03 (C)(2)(f).

214. PREPA did not identify correctly and clearly the variables used in the commercial sector load forecast, in addition to CDD and a monthly dummy variable: the Proposed IRP language states that the forecast used GNP (and not population), while the workpapers show that the forecast used population (and not GNP). In order to determine the net result of this discrepancy, the Energy Bureau conducted a regression analyses using 1) GNP and the weather and dummy variables only, and 2) GNP, population, and the weather and dummy variables. This regression analysis found that the alternate linear fits have somewhat better adjusted r-squared values (0.65 for the fit with GNP only and 0.67 using both GNP and population, compared with 0.59 using population only). However, the regression analysis using all variables produces the nonsensical result that the commercial load is inversely related to population (for a given GNP, the fit would project that commercial energy load rises as population falls). The regression analysis using only GNP (that is, consistent with the text of the Proposed IRP itself) produces a load forecast that is relatively close to the forecast that PREPA used in the Proposed IRP: the two forecasts are within 500 GWh per year throughout the analysis period. This range is small compared with the uncertainty reflected in the high and low load forecasts. The relatively low r-squared for the commercial sector regression fit (relative to the residential and industrial sectors) indicates that there are other dynamics or drivers of commercial load that PREPA has not taken into account in its load forecast. The net effects of this uncertainty, and of PREPA's lack of explanation of its choice of regression variables, are relatively small. Notwithstanding the foregoing, the Energy Bureau **ORDERS** PREPA to undertake further analysis of the commercial load forecast in its next IRP, including analysis of the use of other independent variables.

215. Regulation 9021 requires that the load forecast "take into account all anticipated naturally occurring EE, as well as any EE resulting from existing and expected building codes and appliance standards."[163] PREPA's forecast meets this standard by using historical relationships between economic variables and energy consumption to derive the coefficients of the regression. This method captures historical trends of increasing EE. Given the current absence of any programmatic utility-sponsored EE in Puerto Rico,

[162] *See* Regulation 9021, § 2.03 (C)(2)(b).

[163] *See* Regulation 9021 § 2.03 (C)(2)(d).

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

this reflects a baseline future case with naturally occurring efficiency but without such programs, as required by Regulation 9021.

216. Intervenors in the proceedings did not identify any fundamental problems with the econometric load forecasting methodology included in the Proposed IRP or the overall results. Several intervenors, however, raised concerns that the impact of EV charging was not factored into PREPA's load forecast. PREPA acknowledged in a discovery response that EV demand was not factored in the load forecast.[164] As detailed above, expert witnesses for some intervenors pointed to the significant increase in load that could result from expanding EV adoption on the Island over the next two decades, and in briefs, intervenors reiterated their concerns regarding electric vehicles.

217. RMI presents a potential impact of EV charging as much as ten times the high end of PREPA's calculation. At this much higher level of adoption, the electric sales impacts would be large – approximately one third of the utility sales for other purposes, instead of less than five percent. As discussed in the Evidentiary Hearing, if electric vehicle sales were to proceed on the path described by RMI, rather than on the path modeled by PREPA, PREPA would have some time to adjust and adapt its load forecasts and resource plans.[165] PREPA could also use time-varying rates or other tools to encourage EV charging to occur during times when the costs to the electric grid are lower (off-peak).[166]

218. An IRP should evaluate resource plans and approaches against a range of potential future loads to evaluate the robustness of its Action Plan and Preferred Resource Plan in the face of uncertainty. This is why Regulation 9021 requires the use of high, base, and low load forecasts.[167] The future adoption of EVs is only one of many sources of uncertainty in the future electric load. In addition to the high, base, and low load forecasts, in this proceeding PREPA also developed No EE and Low EE forecasts (described in detail in Part III(B)) that broaden the span of potential future loads to be served by the utility.

219. While the Energy Bureau is concerned that PREPA did not include EV loads explicitly in its load forecast, based on the evidence presented by PREPA and RMI, we believe that the impact on the load within the next few years will be small, and well within the range of uncertainty expressed by the range of load forecasts examined in the Proposed IRP. However, the Energy Bureau is also aware that EV loads could be large in the future. In order to fully explore this source of uncertainty, the Energy Bureau **ORDERS** PREPA to develop and incorporate EV forecasts into the next IRP. These EV forecasts must

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164 PREPA's response to Energy Bureau's ROI 1, PREB-PREPA-01-18(g), August 2, 2019.

165 Evidentiary Hearing, February 4, 2020, morning session, 00:29:30 to 00:31:15.

166 *Id.* at 00:31:15 to 00:32:00.

167 *See* Regulation 9021 § 2.03(C)(2)(a).

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

include a range of potential EV adoption rates that are consistent with Puerto Rico's stated public policy, be informed by Puerto Rico and mainland U.S. automobile markets, and account for the impact of controlled and uncontrolled EV charging on peak demand.

220. While the Energy Bureau has identified two areas for improvement in the load forecast, PREPA has conducted forecasts that are consistent with the Regulation 9021. The range of load forecasts used for resource plan evaluation, including the high and low load forecasts as well as the "no energy efficiency" and "low energy efficiency" cases (discussed in Part III(B)) result in a wide range of potential loads for evaluation in the Proposed IRP, as envisioned by Regulation 9021. This range of load forecasts reflects good practice for resource planning in the face of the kind of uncertainty that Puerto Rico faces in terms of its future economy, population, and technology adoption. For these reasons, the Energy Bureau **ACCEPTS** PREPA's filed load forecasts for the purpose of this IRP.

B. Energy Efficiency and Demand Response

221. Section 2.03(F)(3) of Regulation 9021 establishes that "[t]he IRP shall identify and include a wide range of potential new energy efficiency and demand response programs." The IRP must include all demand-side programs currently in operation, and consider all available cost-effective EE and DR measures and programs. The IRP must also consider bundles of demand-side resources and varying levels of cost and effectiveness and their implementation throughout the planning period. In addition, the IRP should identify constraints on acquisition of demand-side resources such as program ramp rate, expected lifetime, and availability.[168]

222. Until such time as the Energy Bureau has approved the results of an EE and DR potential study, which would identify the size and shape of Puerto Rico's cost-effective demand-side resource, Regulation 9021 requires that the IRP consider the cost and impact of developing and implementing programs that target savings of at least two percent (2%) per year, for at least 10 years. On April 26, 2019, the Energy Bureau ordered PREPA to "model EE with gains of two percent (2%) per year, based on the energy sales of that year (or the previous year), for 18 years from 2020 to 2037 (inclusive)."[169]

223. In October 2019, the Senate of Puerto Rico passed S. B. 1427. This bill, if enacted, would repeal Article 6.29B of Act 57.[170] Article 6.29B establishes the goal of thirty percent (30%) EE by 2040, requires the Energy Bureau to promulgate EE regulations, and aims to replace all streetlights in Puerto Rico with Light Emitting Diodes (LED). In order to

[168] *See* Regulation 9021 § 2.03(F)(3)(a)-(f)

[169] Resolution and Order, In Re: Review of the Puerto Rico Electric Power Authority Integrated Resource Plan, Case. No. CEPR-AP-2018-0001, April 26, 2019, page 4.

[170] As of the date of this Final Resolution and Order, S.B. 1427 has not passed in the House.

understand the potential impacts if this bill were to be enacted, the Energy Bureau ordered PREPA to develop and model cases with No EE and Low EE.[171]

1. PREPA Filing

224. Appendix 4 to the Proposed IRP contains details of PREPA's assumptions and modeling regarding EE and DR programs. PREPA also filed a workpaper (the "EE and DR Workpaper") that contains the calculations for EE and DR programs and results that are described in Appendix 4 to the Proposed IRP (Appendix 4).[172]

a. Energy efficiency

225. Appendix 4 and the EE and DR Workpaper describe modeled programs that, together, would accumulate to 35.8% of sales by 2038. The average annual EE savings presented is 2.26% of sales, although the annual savings ranged from 1.94% to 3.25%. PREPA projects peak load reductions from EE of 86 MW in 2020, rising to 814 MW of peak load reduction by 2038.[173]

226. The first-year savings presented in Appendix 4 are higher than average (3.25%) because they include savings from increased efficiency in the reconstruction after Hurricanes Irma and María. As described, these savings would be achieved without utility programs. PREPA modeled these savings as occurring naturally in 2019 and 2020.[174] PREPA did not present any evidence regarding whether, in fact, these naturally-occurring savings have occurred during the reconstruction that has taken place to date. Absent these "reconstruction efficiency" savings, the total savings by 2038 is 34.6% of sales, with average annual savings of 2.17% of sales.

227. The efficiency programs modeled in Appendix 4 and the EE and DR Workpaper are residential air conditioning (AC), residential lighting, commercial air conditioning, commercial lighting, street lighting, and reconstruction efficiency.

- The residential AC program would offer a $50 rebate for purchase of a SEER 12 (Energy Star) window air conditioner. PREPA also assumes a cost of $150 per participant to administer the program, and savings of 500 kWh per year, per unit. This equates to a cost of $400 per first-year MWh. PREPA assumes window ACs are used for ten years. With a nine percent (9%) discount rate, the levelized utility cost of saved energy for this program would be 6.2

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[171] Energy Bureau's ROI 9, October 29, 2019, 09-01.

[172] Workpaper, "EE-DSM Cost Calculation FOR PREPA 04-12-19_PREB Reference_30_ TJP Update-v4newTRCs.053019.xlsx"

[173] PREPA's response to Energy Bureau's ROI 1,18(e), August 2, 2019.

[174] *See* Proposed IRP, Appendix 4, page 2-10.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

cents/kWh. In its model, PREPA assumes that 7.5% of households would take advantage of this program each year.

- The residential lighting program would offer five free LED light bulbs to each participating household. PREPA assumes a cost of $65 per participating household for five bulbs ($5 per bulb) and administration cost ($40 per household) of the program, and savings of 172 kWh per year, per household. This equates to a cost of $378 per first-year MWh. PREPA assumes LED bulbs last 19 years. With a nine percent (9%) discount rate, the levelized utility cost of saved energy for this program would be 4.2 cents/kWh. PREPA assumes that ten percent (10%) of households would take advantage of this program each year.
- The commercial AC program would offer a $700 incentive for purchase of a SEER 17 air conditioner. PREPA also assumes a cost of $500 per participant to administer the program, and savings of 1,750 kWh per year, per unit. This equates to a cost of $686 per first-year MWh. PREPA assumes the ACs are used for twenty years. With a nine percent (9%) discount rate, the levelized utility cost of saved energy for this program would be 7.5 cents/kWh. PREPA assumes that ten percent (10%) of commercial customers would take advantage of this program each year.
- The commercial lighting program would offer an incentive for high-efficiency lamps in commercial establishments. PREPA assumes an incentive of $3,900 per participant, program administration costs of $2,000 per participant, and savings of 15,000 kWh per year, per commercial establishment. This equates to a cost of $378 per first-year MWh. PREPA assumes LED bulbs last 19 years. With a nine percent (9%) discount rate, the levelized utility cost of saved energy for this program would be 4.4 cents/kWh. PREPA assumes that nine percent (9%) of commercial customers would take advantage of this program each year.
- A street lighting program would replace all streetlights with LEDs by 2024. PREPA assumes that public funding would be available for this program, so there would be no ratepayer cost. PREPA models savings of 208 GWh per year (with associated energy savings of $48 to $51 million per year) once all the streetlights have been replaced.
- Reconstruction efficiency assumes that households recovering from Hurricanes Irma and María will replace equipment with more efficient equipment, based solely on more efficient baseline equipment today than when the damaged equipment was purchased. PREPA assumes that these savings occur naturally during rebuilding (*i.e.*, requiring no utility program or expenditure), and provide annual savings of 180 GWh and between $44 and $46 million.

228. The total utility cost for the programs in Appendix 4 is modeled as approximately $110 million per year, rising at approximately two percent (2%) per year. The present value

of the Base EE program cost is $982 million at a nine percent (9%) discount rate. PREPA did not include this cost in the NPV cost of the different scenarios presented in the IRP. The Proposed IRP contains the same EE programs in each case, so the exclusion of the cost of EE programs does not change the relative cost of the cases presented in the filed IRP.

229. PREPA did not model or otherwise explicitly account for EE acquired through non-utility programs, beyond the reconstruction efficiency and street lighting programs. PREPA did not explicitly account for appliance standards, building codes, or weatherization programs funded by other sources. PREPA's regression-based load forecast captures some "naturally occurring" efficiency of these sorts to the extent that the underlying trend of electric consumption as a function of population and economic activity reflects historical non-utility-program efficiency.

i. No EE and Low EE cases

230. The No EE case filed in response to the Energy Bureau's Ninth ROI contains no EE, although it retains DG and the same DR resource as the Base EE case.[175]

231. The Low EE case filed in response to the Energy Bureau's Request of Information contains approximately one third of the EE included in Appendix 4. This level of efficiency was modeled as being achieved through smaller versions of the same programs as Appendix 4.[176] For example, residential AC ramps participation up to five percent (5%) over 5 years, beginning in 2021, instead of assuming ten percent (10%) in 2020 and each year thereafter.[177] Residential lighting ramps to five percent (5%) by 2023,[178] commercial AC ramps to only 0.3% by 2025,[179] and commercial lighting to three percent (3%) by 2023.[180] PREPA models each program as continuing to grow slowly after reaching its ramped-in level. Street lighting and reconstruction efficiency savings are unchanged,[181] and therefore represent a larger fraction of the total savings in the Low EE case.

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[175] PREPA's response to Energy Bureau's ROI 9, Section 2.1.1, November 27, 2019.

[176] Program adjustments are described in general terms in PREPA's response to Energy Bureau's ROI 9, Section 2.1.2, November 27, 2019, and in specific terms in the file "PREB-PREPA ROI_9_01 Attach 1.xlsx".

[177] PREPA's response to Energy Bureau's ROI 9, Section 2.1.2, November 27, 2019, "PREB-PREPA ROI_9_01 Attach 1.xlsx", sheet "PR EE RES AC."

[178] *Id*. at Sheet "PR EE RES LIGHT."

[179] *Id*. at Sheet "PR EE Comm AC."

[180]*Id*. at Sheet "PR EE Comm Ltg."

[181] *Id.* at Sheets "Street Lighting" and "Reconstruction Efficiency", compared with the sheets of the same names in the EE and DR Workpaper.

232. In the Low EE case, cumulative EE savings by 2038 are 10.8%.[182] Average annual savings are 0.54% of retail sales. Without reconstruction efficiency, the average annual savings falls to 0.48% and the cumulative savings to 9.5%.

233. PREPA does not assume changes in the per-participant costs of the EE programs in the Low EE case. Nonetheless, the programmatic costs of acquiring efficiency change because of the contributions of different programs and their ramp rates. Total programmatic costs rise from $19.8 million in 2021 to $39.3 million in 2025 and then climb slowly.[183] The present value of the Low EE program cost is $286 million at a nine percent (9%) discount rate. PREPA did not include this cost in the NPV cost of the different scenarios presented in the Proposed IRP or discovery responses. When comparing the net cost of scenarios with different levels of EE (*i.e.*, the Base EE, Low EE, and No EE scenarios), it is necessary to add the cost of the different EE programs to the NPV to create a fair comparison of the total costs to ratepayers. *See* Table 13 below.

234. At the evidentiary hearing, Dr. Bacalao testified that EE is a "given" with respect to meeting customer needs cost-effectively.[184] However, Mr. Saenz testified that he believes that the No or Low EE case is a more likely level of EE to plan for than the base case.[185] Dr. Bacalao stated that 0.5-0.6% annual EE is very achievable; this level is comparable to the Low EE case.[186] He stated that the level of participation required in the modeled programs in order to achieve two percent (2%) annual savings is very high, and that this level of participation may be difficult to achieve.[187] However, Dr. Bacalao stated that if other end uses, such as water heating, were also included there would be less participation required in any given program in order to achieve the overall two percent (2%) savings.[188]

b. Demand response

235. Appendix 4 also contains details of PREPA's assumptions and modeling regarding DR programs. The EE and DR Workpaper contains the calculations for DR, the results of which are presented in Appendix 4. Appendix 4 and the EE and DR Workpaper describe DR programs that, together, accumulate to 82.5 MW by 2038.

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182 Cumulative savings across years and programs are in the Sheet "Summary of EE Savings" in the file "PREB-PREPA ROI_9_01 Attach 1.xlsx".

183 "Summary of EE Savings" in the file "PREB-PREPA ROI_9_01 Attach 1.xlsx."

184 Evidentiary Hearing, February 4, 2020, morning session, 01:02:30.

185 *Id*. at 49:30.

186 *Id*. at 01:04:00.

187 *Id*. at 03:29:00.

188 *Id*. at 03:31:00.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

236. The DR programs modeled in Appendix 4 utilize controlled residential air conditioning and a commercial program controlling both air conditioning and lighting.

- The residential DR program assumes a Wi-Fi thermostat to control air conditioning. The utility incurs a one-time cost of $200 per participant for the thermostat installation and setup costs, and $160 per participant in annual recurring costs for project management and administration. Participants receive $100 per year in payments for the peak reductions they deliver, which average 1.2 kW per participant. PREPA assumes that one percent (1%) of customers sign up each year, with eighty percent (80%) of the participants each year continuing into the following year. In 2025, for example, the program delivers 51.8 MW of peak savings for a cost of $14.8 million, or an equivalent capacity cost of $285/kW-year.[189]
- The commercial DR program assumes that small and medium-sized commercial customers would install and utilize Wi-Fi thermostats, lighting controls, and associated communication software. The utility incurs a one-time cost of $400 per participant for the thermostat installation and setup costs, and $2,000 per participant in annual recurring costs for project management and administration. Participants receive $3,000 per year in payments for the peak reductions they deliver, which average 6 kW per participant. PREPA assumes that between 1,200 and 1,400 businesses would participate. In 2025, for example, the program delivers 8.4 MW of peak savings for a cost of $7.5 million, or an equivalent capacity cost of $889/kW-year.[190]

237. PREPA assumed that pharmaceutical manufacturers would not participate "due to the need for tightly controlled environments all hours of the day".[191] PREPA further states that "[t]ypical participants well-suited to such a program include hotels/motels, office buildings, non-food retail establishments, and educational facilities."[192]

238. PREPA did not present evidence indicating that PREPA has consulted with or gathered information from its commercial or industrial customers regarding their willingness or ability to participate in DR programs. However, during the evidentiary hearing presentation regarding the impact of the January 2020 earthquakes, PREPA described the ability of some industrial customers to provide their own power during and after emergency situations. In particular, PREPA described how industrial customers were providing their own power in order to maintain power quality and reliability, both in

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[189] Sheet "PR Res DR" in the PREPA Workpaper, "EE-DSM Cost Calculation FOR PREPA 04-12-19_PREB Reference_30_ TJP Update-v4newTRCs.053019.xlsx."

[190] Sheet "PR Comm DR" in the PREPA Workpaper, "EE-DSM Cost Calculation FOR PREPA 04-12-19_PREB Reference_30_ TJP Update-v4newTRCs.053019.xlsx."

[191] *See* Proposed IRP, Appendix 4, page 2-3, Exhibit 2-9.

[192] *Id.*

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

the immediate days after the earthquakes[193] and as late as the time of the hearings several weeks after the earthquakes.[194] Based on the load data presented at the evidentiary hearing, after service had been restored to almost all customers on January 15, actual load of 2068 MW was still substantially lower than the forecast load of 2302 MW.[195]

239. PREPA assumes an avoided capacity cost of $1,000/kW-year, but does not provide a basis for this assumption.[196] Both modeled residential and commercial DR programs cost less than PREPA's assumed avoided cost. The combined modeled portfolio has a capacity cost of $370/kW-year.

240. PREPA did not model distributed storage as a resource type in the Proposed IRP, and therefore did not consider distributed storage as a DR resource at either residential or commercial scale. During the IRP Evidentiary Hearing, Mr. Ortiz stated that aggregated distributed solar and storage (sometimes referred to as VPPs) are implicit in the Proposed IRP.[197] Moreover, at the evidentiary hearing, Dr. Bacalao testified that distributed storage that is able to be controlled or dispatched by the utility is operationally equivalent to the storage that is modeled as a utility resource.[198] However, they are not modeled explicitly.[199]

2. Intervenors

a. AES Puerto Rico

241. In its final brief, AES Puerto Rico (AES-PR) urges the Energy Bureau to approve an IRP that moves "forward promptly with 'no regrets' investments in solar energy and EE measures".[200]

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193 Evidentiary Hearing, February 3, 2020, morning session, at 00:40:20.

194 *Id*. at 01:51:15 to 01:54:00.

195 *Id*. at 00:40:20.

196 Workpaper, "EE-DSM Cost Calculation FOR PREPA 04-12-19_PREB Reference_30_ TJP Update-v4newTRCs.053019.xlsx".

197 Evidentiary Hearing, February 7, 2019, morning session, 00:44:40.

198 Evidentiary Hearing, February 4, 2019, afternoon session, 1:16:00, and Evidentiary Hearing, February 6, 2019, morning session, 02:26:00.

199 *Id*.

200 AES-PR, Final Brief, March 6, 2020, page 1.

b. Environmental Defense Fund

242. Dr. Elizabeth Stanton, expert witness for EDF, testifies that PREPA's EE projections accumulate to 35% total reduction, rather than the 30% required by Act 17.[201] Dr. Stanton states that PREPA has underestimated the future electric demand in Puerto Rico by assuming more EE than is called for in Act 17. She identifies that "underestimating demand can lead to underestimation of supply and, therefore, reliability issues" and also that "(I)f demand is underestimated, so too is the expected amount of renewable capacity and generation necessary to comply with the RPS."[202] Put simply, according to Dr. Stanton, "undercounting demand leads directly to less planned renewable generation".[203]

243. In its Final Brief, EDF recommends that "PREPA immediately begin developing cost-effective energy efficiency and DR programs, and commit substantial efforts toward the development of these programs."[204] Nonetheless, EDF states that the Proposed IRP does not reflect "realistic amounts of energy efficiency" because it assumes that PREPA would meet or exceed the Act 17 EE targets even though there are no EE programs in place or under development today.[205] EDF contends that the Proposed IRP did not "identify or evaluate" potential EE and DR solutions, despite the Energy Bureau and statutory direction to take into account the potential for demand-side measures.[206] EDF criticizes the Proposed IRP for not including water heating efficiency or for analyzing whether residential demand had been impacted by replacement of home appliances after Hurricane María.[207] EDF suggests that the Action Plan include EE and DR programs budgeted at $300 million or more and argues that these programs would be cost-effective within this budget, "if not well in excess of this amount."[208] Regarding DR in particular, EDF urges the development of an interruptible load program for large commercial and industrial customers, especially in light of the need for summer peak capacity in the aftermath of the January 2020 earthquakes.[209] EDF recommends using flexible loads, including electric vehicles, to provide benefits to the grid.[210] EDF suggests that in future IRP modeling, the modeling tool should permit the evaluation of different

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201 EDF, Testimony of Dr. Elizabeth Stanton, October 23, 2019, page 13.

202 *Id*. at page 15.

203 *Id*. at pages 15-16.

204 EDF, Final Brief, March 6, 2020, at page 2.

205 *Id*. at page 21.

206 *Id*. at page 23.

207 *Id*. at page. 23.

208 *Id*. at page 46.

209 *Id.* at pages 46-47.

210 *Id.* at page 47.

levels of EE, DR, and other demand-side resources, ranging from no investment up to the maximum technical potential for each resource.[211]

c. Independent Consumer Protection Office

244. In its Final Brief, ICPO criticizes PREPA for dismissing solar water heaters as a potential EE measure. ICPO states that water heating is one of the largest consumers of energy in Puerto Rico homes and it is unreasonable for PREPA to have dismissed efficiency measures for this end use.[212] ICPO further points out that solar water heating is a widely available technology in Puerto Rico, there is a local solar water heater manufacturing industry, and that the home weatherization program has been successful largely due to efficiency measures, including solar water heaters.[213]

d. Local environmental organizations

245. Mr. Ronny Sandoval, expert witness for the LEOs, addresses the markets covered by PREPA's modeled EE programs (as presented in Appendix 4).[214] Mr. Sandoval states that the pace of efficiency acquisition within the residential and commercial markets could be higher, and cover more end uses than those included on page 4 of Appendix 4. In particular, Exhibit LEO-Sandoval-Supp-1 identifies greater uptake of lighting and air conditioner efficiency and of commercial DR than included in Appendix 4, and adds solar hot water heaters, refrigerators, distributed solar PV and energy storage, and conservation voltage reduction.

246. Exhibit LEO-Sandoval-Supp-1 presents a range of potential additional peak demand reductions from adoption of these measures, increasing over time. In the moderate case, the peak reduction in 2025 would be 144 MW, and in 2038 it would grow to 236 MW.[215] In the aggressive case, the peak reduction in 2025 would be 184 MW, and in 2038 it would grow to 328 MW.[216] Exhibit LEO-Sandoval-Supp-1 suggests that this additional EE and demand management could avoid the need to construct an additional centralized plant in 2025.[217]

247. Exhibit LEO-Sandoval-Supp-1 further presents levelized costs for the demand-side measures that range from 3 cents/kWh for conservation voltage reduction to 12

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[211] *Id*. at pages 57-58.

[212] ICPO, Final Brief, March 6, 2020, page 12.

[213] *Id.* at pages 12-13.

[214] LEOs, Supplemental Testimony of Ronny Sandoval, December 11, 2019, Exhibit LEO-Sandoval-Supp-1.

[215] *Id.* at page 26.

[216] *Id*.

[217] *Id*.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

cents/kWh for commercial lighting and 19 cents/kWh for solar water heating.[218] Notwithstanding the foregoing, Mr. Sandoval's cost estimates are based on experiences in other U.S. jurisdictions, rather than on Puerto Rico-specific estimates.

248. In his Supplemental Testimony, Mr. Sandoval addresses the uncertainty regarding the load forecast that results, in part, from uncertainty regarding the performance of future EE programs (page 3-4). Mr. Sandoval suggests that the expansion of efficiency and demand-side management programs to additional measures and segments could be used to manage the uncertainty regarding adoption of the programs in Appendix 4.

249. In their Final Brief, the LEOs contend that PREPA has no plan to incorporate EE or DR, in contrast to detailed plans for the deployment of new gas-fired resources.[219] The LEOs identify a contrast between the compliance with the Act 17 efficiency target that is assumed in the base case and the lack of details regarding how this trajectory will be accomplished.[220] The LEOs argue that PREPA's experts' opinions that the Low EE or No EE cases are the more likely outcome, are a product of PREPA's failure to carry out its critical role in EE.[221] The LEOs recommended actions regarding EE and DR for incorporation in the Action Plan, include pursuit of efficiency in solar water heaters, refrigerators, and other end uses.[222] The LEOs recommend that the Energy Bureau adopt working group recommendations from the Energy Bureau's dockets NEPR-MI-2019-0015, NEPR-MI-2019-0019, and NEPR-MI-2019-0011.[223] The LEOs also urge the Energy Bureau to direct PREPA to engage with commercial and industrial customers to provide DR.[224]

e. Not-for-profit intervenors

250. Mr. Eric Ackerman, expert witness for the not-for-profit intervenors (NFPs), states in his Supplemental Testimony that PREPA should be far more aggressive in driving EE in Puerto Rico.[225] He states that EE is likely to be the most economic source of supply in many situations because of the bankruptcy-related risk premiums that must attend all supply-side investments. He argues that PREPA should be required to enhance its Action Plan to implement a comprehensive strategy for customer engagement, including cost-effective options for EE and DR. Mr. Ackerman suggests that PREPA and

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[218] *Id.* at page 23.

[219] LEOs, Final Brief, March 6, 2020, page 4.

[220] *Id*. at page 24.

[221] *Id*. at page 25.

[222] *Id*. at pages 27-28.

[223] *Id*. at page 28.

[224] *Id*. at pages 28-29.

[225] NFPs, Supplement Testimony of Mr. Erik Ackerman, December 10, 2019, pages. 3-4.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

the Energy Bureau should consider incentives for customer participation in EE and DR programs, including through on-bill financing.

251. In their Final Brief, the NFPs state that PREPA should aggressively drive EE in Puerto Rico for two reasons: first, that EE is likely to be the most economic source of supply, and second that Act 17 mandates a 30% increase in EE by 2040.[226] The NFPs' Final Brief further emphasizes the importance of customer engagement, customer education, and incentives for customer participation in EE and DR programs.[227]

f. Solar and Energy Storage Association of Puerto Rico

252. Mr. Patrick Wilson argues in his pre-filed testimony that EE acquisition, especially between now and 2025, will be slower than modeled in the Proposed IRP. Mr. Wilson suggests that EE acquisition will be zero or near-zero through 2020, 0.1% in 2021 and 2022, 0.5% in 2023 to 2025, and then a ramp up to 30% total savings by 2040.[228] In support of his argument, Mr. Wilson states that programs typically require ramp-up times, and that Puerto Rico faces a set of challenging circumstances, including the financial state of PREPA, the pending effort to award a private firm the operational role regarding the T&D system, and the uncertain timeframe for the adoption of the Energy Bureau's EE regulations.[229]

253. During the evidentiary hearing, Mr. Wilson testified about "quick start" EE programs of which he has recently become aware through the Energy Bureau's ongoing workshop process on EE.[230] He testified that "quick start" programs could alleviate some of his concerns regarding the ability of efficiency programs to achieve savings quickly.

g. Sunrun

254. Mr. Christopher Rauscher of Sunrun testified that the Proposed IRP "should not remain 'silent'" on the capabilities of distributed solar and storage.[231] According to Mr. Rauscher, "[i]nstead its capabilities should be articulated, target scale agreed, and routes to procurement identified."[232] Mr. Rauscher states that customers who install solar and storage for resilience and reliability can share a significant portion of their battery capacity with the utility for energy management during non-emergency

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226 NFPs, Brief, March 6, 2020, page. 15.

227 *Id*.

228 SESA-PR, Testimony of Patrick Wilson, October 23, 2019, page 13.

229 *Id*. at page 12.

230 Evidentiary Hearing, February 4, morning session, 03:45:30.

231 Sunrun, Testimony of Christopher Rauscher, October 23, page 4.

232 *Id*. at page 4.

times.[233] Mr. Rauscher states that Sunrun has participated in projects that have delivered aggregated storage as a capacity resource in New England and in Hawaii, with thousands of participants for an average of about 4 kW per participating home.[234] The ISO-NE Capacity Market auction in which Sunrun's storage resources were selected had a final clearing price of $3.80/kW-month ($45.60/kW-year).[235]

255. At the evidentiary hearing, Mr. Raucher testified that distributed storage resources of the sort deployed by Sunrun are capable of providing the controlled dispatch required in order to meet Dr. Bacalao's description of distributed storage resources that can be treated as equivalent to utility resources for the purposes of modeling.[236] He further testified that distributed storage resources may be cost-effective for utility use because the utility payments are paying for services provided and contributing to the cost of the battery systems, but are not required to cover the entire cost of the battery.[237]

256. In its Final Brief, Sunrun states that that the services provided by VPPs are indistinguishable from those of fossil generation peakers[238] and that the Energy Bureau's final order should identify VPPs as a no-regrets option in the Action Plan.[239]

3. Amicus Curiae

a. Rocky Mountain Institute

257. In its Amended *Amicus Curiae* Brief of December 20, 2019, RMI states that EE progress will likely be slower than anticipated in PREPA's load forecast and the EE programs in Appendix 4, and demand will therefore be higher than anticipated in the early years.[240] RMI describes that Appendix 4 assumes that EE programs achieve two percent (2%) per year in savings in 2020, while the Energy Bureau's draft third party administrator approach for EE, as described in the draft Regulation on Energy Efficiency and Demand

[233] *Id*. at page 6.

[234] *Id*. at page 12-13.

[235] ISO New England, "Markets," https://www.iso-ne.com/about/key-stats/markets#fcaresults, regarding FCA #13 in 2019. Accessed April 13, 2020.

[236] Evidentiary Hearing, February 4, 2020, afternoon session 01:04:00 to 01:06:00.

[237] Evidentiary Hearing, February 7, 2020, morning session, 03:41:00.

[238] Sunrun, Final Brief, March 6, 2020, page 1.

[239] *Id*. at page 2.

[240] RMI, Amended *Amicus Curiae* Brief, December 20, 2019, page 7.

Response,[241] begins a process in 2019 that would not result in full implementation of EE programs until 2021.[242]

258. In Appendix 1 to the Amended *Amicus Curiae* Brief, RMI states that a recent peer-reviewed scientific publication explains that "modern EE 'shows every sign of durably remaining, an expanding-quantity, declining-cost resource.'"[243] RMI observes that EE is consistently the cost-effective energy resource that provides durable benefits to customers. The brief further states that utility ratepayer-funded EE programs have led to sizable savings for customers. The brief states that Hawaii ratepayers pay 2.1 cents per kWh for saved energy, resulting in tens of millions of dollars in savings each year.[244]

4. Discussion

a. Energy efficiency

259. PREPA has presented modeling based on ratepayer-funded EE programs for residential and commercial lighting and cooling that cost between 4.2 and 7.5 cents per kWh. The portfolio-level average cost is 4.8 cents per kWh (not counting street lighting or reconstruction efficiency). This EE furthermore provides a capacity resource by reducing peak loads by 0.13 kW for each MWh of energy savings.[245]

260. In order to achieve the two percent (2%) annual EE savings level consistent with the statutory EE target, PREPA assumed that participation in these limited programs would be high. As addressed by Mr. Sandoval and in the evidentiary hearing, other end uses, such as water heating, may be sources for additional cost-effective EE. Programs that address other end uses would also reduce the level of participation required to meet the statutory efficiency target by 2040. As stated by RMI, EE programs in Hawaii (with a similar tropical island climate) achieve savings at a cost of 2.1 cents per kWh, so it is possible that ratepayer-funded EE in Puerto Rico may be achievable at costs substantially lower than modeled by PREPA.

261. As addressed later in this Final Resolution and Order, the supply-side energy resources that PREPA considers in the Proposed IRP have levelized costs in 2021 of between 5.8 cents/kWh (Low Case Solar PV[246]) and 14.6 cents/kWh (Medium-sized CCGT running

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[241] Resolution, In Re: Regulation for Energy Efficiency and Demand Response, Case No. NEPR-2019-0015, September 4, 2019.

[242] RMI, *Amicus Curiae* Brief, December 20, 2019, page 7.

[243] *Id*. at page 26.

[244] *Id*.

[245] Calculated from Proposed IRP, Exhibits 3-24 (page. 3-21) and 3-25 (page 3-22).

[246] *See* Proposed IRP, Exhibit 6-31, page 6-23.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

on diesel at 90% capacity factor[247]). (We have not included peakers or other resources intended to supply capacity in this comparison, but they generally have even higher levelized costs of energy.) Even at the EE costs as modeled by PREPA, the evidence in this docket indicates that EE is, on average, Puerto Rico's least cost energy resource. While the eventual cost of saved energy in Puerto Rico is unknown, the Energy Bureau **FINDS** that based on the evidence presented in this proceeding, EE is a lower cost resource than any supply-side resource evaluated in the proposed IRP.

262. EDF contends that the IRP did not "identify or evaluate potential demand-side management (DSM) solutions - EE programs, DR programs and DG … although Act 17-2019, Act 57-2014, the IRP Rules and Energy Bureau's previous IRP Order clearly directed PREPA to take into account DSM's potential."[248] The Energy Bureau disagrees. PREPA identified and evaluated the savings that would result from implementing EE and DR programs in the residential and commercial sectors, as described in this Final Resolution and Order. The Energy Bureau has not yet approved a potential study for EE or DR in Puerto Rico, and in this circumstance Regulation 9021 explicitly allows a presumption of 2% per year savings to be used, which is what PREPA did. EDF further argues that future IRPs should be structured to allow for modeling different levels of EE, ranging from none to the maximum potential for each resource. The record in this proceeding presents results of analysis comparable to this suggestion, ranging from the No EE case to the presumed potential of 2% per year.

263. Ratepayer-funded programmatic savings are in addition to savings from other approaches, such as building codes, appliance standards, and energy saving actions in government buildings. While Puerto Rico is starting from a basis of almost no EE programs, introducing proven program structures here should allow savings consistent with the statutory 30% target by 2040. Some period to ramp up savings should be expected, although product-based programs, such as residential appliance and lighting programs, and other "fast start" program designs that have been demonstrated in other jurisdictions should be implementable very quickly. The Energy Bureau looks forward to using the input received through its recent workshop process to inform next steps. The Energy Bureau addresses the implications of the facts and opinions presented by the parties regarding EE and DR in the Action Plan in Part IV of this Final Resolution and Order.

264. Parties in this case have made numerous arguments regarding the amount of EE that PREPA should plan for in the Proposed IRP, even though PREPA modeled a wide range. However, the amount of efficiency that will be acquired is uncertain. This uncertainty

[247] *See* Proposed IRP, Exhibit 6-21, page 6-16. Lower capacity factors have higher levelized costs of energy.

[248] EDF, Final Brief, March 6, 2020, page 23.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

largely reflects uncertainty in funding and program designs that will work in Puerto Rico, not uncertainty in the existence or reliability of the resource.

265. Evaluation of EE in the next PREPA IRP should be informed by further actions and studies. The Energy Bureau intends to undertake market baseline and potential studies within the next year, in order to inform itself, PREPA, and other stakeholders regarding the current level of efficiency in Puerto Rico homes and businesses, and the achievable scale and pace of efficiency improvements. For the next IRP, the Energy Bureau **ORDERS** PREPA to utilize the results of these studies in developing projections of future EE.

266. This proceeding did not develop evidence regarding the relative cost and performance of the EE programs modeled by PREPA with best practice in efficiency programs achieved elsewhere in the United States. For the next IRP, the Energy Bureau **ORDERS** PREPA to compare the costs and performance of the EE programs modeled in the Proposed IRP with similar and best-practice programs elsewhere.

267. PREPA did not account for non-utility actions that increase EE explicitly in its load forecast or efficiency projection. For the next IRP, the Energy Bureau **ORDERS** PREPA to account for federal appliance standards, building codes, and relevant governmental programs, such as weatherization assistance or other local programs (*i.e.*, from the central government and/or municipalities) to improve EE in government facilities, in developing its load forecast and EE projections.

b. Demand response

268. PREPA modeled a DR resource that reaches a level of somewhat less than 5% of PREPA's peak load in 2038. Based on the evidence presented, this appears to be a reasonable starting point for the potential of traditional DR, although the actual cost and performance of Puerto Rico DR programs are uncertain because they have not been designed or implemented. In particular, PREPA presents little justification for either the programmatic cost or avoided cost for DR, and no intervenors presented additional or contrary evidence. The Energy Bureau **ACCEPTS** the evidence on the cost-effectiveness of DR that PREPA has presented, for the purposes of the Proposed IRP. Notwithstanding the foregoing, the Energy Bureau **ORDERS** PREPA to promptly develop programmatic costs based on market response to the Energy Bureau's Regulations on Demand Response after they are issued, and informed by PREPA's process of negotiation, coordination and scheduling with commercial and industrial customers as required by the Energy Bureau's Order and Resolution of May 22, 2020 in case NEPR-AP-2020-0001.

269. Currently, PREPA has a significantly low level of customer engagement with large industrial or commercial customers regarding DR efforts. Improved engagement with these customers could inform future plans for DR resource development and utilization. The experience with industrial self-supply after the January 2020

earthquakes indicates that a significant amount of industrial self-supply generation may be available (approximately 200 MW) as an emergency DR resource, if PREPA were to harness it as such. This is a substantially larger capacity than PREPA modeled as a DR resource in the Proposed IRP, although its use would be limited to emergency use by the allowed run-times of the customer generators and by any policies and environmental regulations that limit the use of fossil fuel systems for DR.

270. We understand that storage is treated as a utility resource in the Proposed IRP, and is dispatched in the modeling as a utility asset. However, based on the evidence presented in this docket regarding VPPs and distributed storage, it is reasonable to assume that behind the meter storage could also be used to provide a DR or capacity service. Where this service has been offered by distributed storage in other jurisdictions (such as in ISO-NE), the cost as a capacity resource (in $/kW-year) is much lower than the DR resources considered by PREPA in the Proposed IRP. This indicates that distributed storage may be a cost-effective DR resource in Puerto Rico to the extent that it is not accounted for as a utility grid asset. Behind the meter storage that can act as a grid asset which may also be less expensive to PREPA than utility-owned storage.

271. The Energy Bureau **ACCEPTS** PREPA's projection regarding the quantity of DR for the purposes of the Proposed IRP, and **ORDERS** that distributed storage resources that can provide DR services be accounted for as part of the utility storage resource modeled in the next IRP.

272. The Energy Bureau expects to finalize its Regulation on Demand Response, as required by Act 17-2019, within the next few months. This Regulation will enable PREPA and other stakeholders to develop a more concrete picture of the DR resource available in Puerto Rico. For the next IRP, the Energy Bureau **ORDERS** PREPA to develop a DR resource projection that reflects information gained through implementation of the Energy Bureau's forthcoming Regulation on Demand Response. The Energy Bureau further **ORDERS** PREPA to explicitly account for distributed storage resources as DR resources, part of a VPP, or both. As part of this projection, the Energy Bureau further **ORDERS** PREPA to account for the potential of interruptible load tariffs for large commercial and industrial customers.

C. Existing Resource Options – Description and Documentation

1. IRP Requirements

273. Section 2.03(D) of Regulation 9021 establishes that "PREPA shall describe all existing resources that serve or meet PREPA's customer's energy and capacity requirements." Under Section 2.03(D)(1)(a) of Regulation 9021, the IRP must describe each type of supply-side resource including, but not limited to, the following categories: utility-owned generation, wholesale power purchase transactions, cogeneration and small

power production, DG, pooling or coordination agreements that reduce resource requirements, and any other supply-side resource.

274. Pursuant to Section 2.03(D)(1)(b) of Regulation 9021, the body of the IRP must contain an existing resource table that provides the following information: resource type, nameplate and peak available capacity, annual capacity factor for each of the last five years, fuel type, ownership information, location, commercial operation date, remaining service life, any anticipated projects or programs that would alter remaining service life, remaining contract life, average annual heat rate for last five years, current fuel costs ($/MMBtu), current variable operations and maintenance (O&M) costs (S/MWh), current total production costs ($/MWh), current fixed O&M, and average annual capital expenditures of the last five years in total dollars.

275. Section 2.03(D)(1)(c) of Regulation 9021requires PREPA to provide the following supplemental information: expected retirement date for any resource expected to retire within the first ten years of the Planning Period; dates of renewal operating licenses and permits; compliance schedule with current, proposed, and reasonably anticipated regulatory and legal requirements; expected capital and operating costs for compliance with current, proposed, and reasonably anticipated regulatory and legal requirements; expected yearly non-environmental capital expenditures for the first ten years of the Planning Period; important changes to resources that have occurred since the approval of the most recent IRP; and a description with quantitative information of how the resource contributes to meeting the requirement for "high efficiency" generation.

2. PREPA Filing

276. PREPA summarizes much of the required Section 2.03(D)(1)(b) information for existing resources in Exhibits 4-1, 4-2, 4-3, 4-4, and 4-5 of the Proposed IRP.[249] The referenced tables include the information identified under Section 2.03(D)(1)(b) except that they do not explicitly provide the production costs ($/MWh) of PREPA's existing units. Although the historical values across units and for the PREPA system are not provided in the Proposed IRP, the elements to calculate historical production costs are available for a reader.

a. Retirements

277. Exhibit 4-2 of the IRP Report, "Estimated Retirement of Units to be Retired Next 10 Years," identifies the retirement schedule of 3,644 MW of existing generation in the next ten years. Exhibit 4-2 identifies 2,298 MW of retirements from 2019 through 2024.

[249] Not all of the resources listed in Exhibit 4-1 of the Proposed IRP are utilized. For example, two of the four Palo Seco steam units (Palo Seco 1 and 2) and two of the four San Juan units (San Juan 9 and 10) are excluded from consideration as capacity resources going forward in Exhibit 4-5 of the Proposed IRP.

These units include: 450 MW Aguirre Steam Unit 1 (2019); 450 MW Aguirre Steam Unit 2 (2019); 410 MW Costa Sur 5 (2020); 410 MW Costa Sur 6 (2020); 378 MW GT peakers (various through 2021); 100 MW San Juan 8 (2021); and 100 MW San Juan 7 (2023). PREPA notes that the retirements shown in Exhibit 4-2 are driven by age of equipment and environmental regulation (*i.e.*, EPA's Mercury and Air Toxics Standard (MATS)) compliance. In addition, pursuant to Act 17, PREPA does not model renewal of the power purchase agreement for the AES coal-fired units when it expires at the end of 2027.[250]

b. Existing resources included in IRP

278. As noted in Section 4.2.1 of the Proposed IRP, PREPA concludes that 5,010 MW of the 6,031 MW of existing capacity within the system would be included in the Proposed IRP based on 2018 operating conditions.[251] PREPA identifies the 5,010 MW of capacity in Exhibit 4-5 of the Proposed IRP. PREPA's difference of 1,020 MW encompasses generation resources and renewable resources described below.

279. Page 4-3 of the Proposed IRP states that 707 MW from eleven existing generation units were not included in the IRP due to operating conditions.[252] Seven of the eleven units, representing 623 MW, were shown in Exhibit 4-6 of the Proposed IRP. These units include: Costa Sur 3 (85 MW), Costa Sur 4 (85 MW), Palo Seco 1 (85 MW), Palo Seco 2 (85 MW), San Juan 9 (100 MW), San Juan 10 (100 MW), and Cambalache 1 (83 MW).

280. The remaining difference of approximately 289.5 MW of capacity between the Proposed IRP Exhibits 4-1, 4-6, and 4-5 reflect renewables: 54 MW of hydropower (Toro Negro 2, Garzas 2, Yauco 1, Caonillas 1, and Río Blanco); 128.1 MW of solar (Windmar Renewable, San Fermín, Horizon Energy, AES Illumina, Oriana Energy Solar, Humacao Solar (Fonroche), and Windmar Solar (Cotto Laurel)); 101 MW of wind (Punta Lima, Pattern Energy); and 6.4 MW of landfill gas (Fajardo and Toa Baja).

281. For the existing solar PPOAs, the Proposed IRP assumes a 22% capacity factor based on the low-end of historical capacity factors.[253] The PPOA contract prices for these and other operational or pre-operational PPOAs assumed in the Proposed IRP are shown in Exhibit 4-19 of the Proposed IRP.[254] These contract prices are $150/MWh for solar,

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[250] *See* Act 17. Section 1.6(3) prohibits the generation of electricity from coal after December 31, 2027.

[251] *See* Proposed IRP, page 4-2.

[252] Page 4-3 of the Proposed IRP references 707 MW, while Exhibit 4-6 identifies 623 MW. The difference of 84 MW is not expressly identified.

[253] *Id*. at page 4-15.

[254] *Id.* at page 4-17.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

$125/MWh for wind, and $100/MWh for landfill gas. The Proposed IRP assumes that the contract price includes RECs and does not have escalation clauses.[255]

282. For the thirty-two (32) renewable energy PPOAs that were not renegotiated, the Proposed IRP modeled the locations as new resources with new pricing.[256] For the solar PPOAs (333.3 MW) that are under renegotiation and identified in Exhibit 4-17 of the Proposed IRP, PREPA models those solar projects as new projects with new solar prices instead of the PPOA price. PREPA notes that actual pricing for re-negotiated PPOA's may deviate from the Proposed IRP modeling assumption for the costs of these resources, reflecting legacy development and carrying costs attributable to delays in financing and construction.[257]

283. Appendix 4 to the Proposed IRP contains demand-side resources, including a high-level description of the 172.75 MW of existing DG resources on PREPA's system.[257]

c. Proposed capital expenditures

284. Under Section 2.03(D)(1)(c) of Regulation 9021, PREPA is required to provide information regarding any anticipated projects or programs that would alter the remaining service life of existing generation. In the Proposed IRP, PREPA referenced a spreadsheet for capital projects for 2019 and 2020.[258]

d. Important changes to resources since the most recent IRP

285. PREPA provides a discussion of changes to laws and regulations since the 2015 IRP in Section 2.2 of the Proposed IRP. PREPA also provides a high-level discussion of trends in solar and energy cost declines in Section 2.3 of the Proposed IRP. In Section 2.4 of the Proposed IRP, PREPA provides a discussion of the 2017 hurricanes. These discussions provide a general context of events impacting Puerto Rico, but the sections do not detail the impact on specific resources since the 2015 IRP.

e. High efficiency generation

286. Under Section 2.03(D)(1)(c) of Regulation 9021, PREPA is required to provide a description with quantitative information of how the resource contributes to meeting the requirement for "high efficiency" generation. PREPA notes that it made two checks for compliance. First, PREPA states that the real levelized costs for new and existing

[255] *Id.* at page 4-187.

[256] *Id.* at page 4-16.

[257] *See* Proposed IRP, Appendix 4, Exhibit 3-1. In addition, the Proposed IRP does not include the Energy Answers 79 MW waste to energy project to be located in Arecibo. *See* Proposed IRP, page 4-16.

[258]

combined cycle gas turbines (CCGT) meet the $100/MWh requirement in 2018 dollars. PREPA notes, however, that the expectation is that the capacity factor would be above 60%.[259] Second, PREPA confirms that at least 60% of the total energy from fossil generation comes from highly efficient units.[260]

f. Operating parameters

i. Steam turbines

287. PREPA includes 2,352 MW of steam turbines in the analysis in the Proposed IRP (eight units).[261] All eight units are subject to the EPA MATS rule and are expected be retired within the next ten years.[262] For example, under the ESM scenario, the model assumes the following retirement schedule: Aguirre Steam 1, 450 MW (2019); Aguirre Steam 2, 450 MW (2019); Costa Sur 5, 410 MW (2020); Costa Sur 6, 410 MW (2020); San Juan 8, 100 MW (2021); San Juan 7, 100 MW (2023); Palo Seco 3, 216 MW (2025); and Palo Seco 4, 216 MW (2025). As shown in Exhibit 4-7 of the Proposed IRP, PREPA provides minimum capacity values for the steam units.[263] PREPA also bases other operating parameters on historical operations of the units and current modeled values for the unit heat rates.

ii. Combined cycle gas turbines

288. PREPA includes 920 MW of CCGTs in the Proposed IRP (four units). These units are San Juan 5 and 6, and Aguirre 1 and 2. At the time of the IRP filing, PREPA listed that the four units operated on diesel fuel.

289. In most scenarios within the Proposed IRP, PREPA modeled the San Juan 5 and 6 units to be converted to operate on natural gas starting in June 2019.[264] This change follows the timeline of the San Juan Unit 5 and 6 natural gas conversion proceeding documented in the Energy Bureau's Case CEPR-AI-2018-001. In August 2018, the Energy Bureau was made aware that PREPA has issued an RFP for the conversion of San Juan Units 5 and 6 from diesel fuel to natural gas.[265] In 2019, the Energy Bureau

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[259] *See* Proposed IRP*,* page 8-16.

[260] *Id.*

[261] *Id.* at page 4-4.

[262] *Id.* at page 4-1.

[263] *Id*. at page 4-5.

[264] Cases S1S2S7B, S3S2B, S3S2H, S3S2L, S3S2B, S3S2, S3S2S5B, and S3S2S8B delay the conversion of one or both units.

[265] Resolution and Order, In Re: Request for Proposals for Conversion of San Juan Units 5 & 6 to Natural Gas, Case No. CEPR-AI-2018-0001, August 14, 2018.

NEPR
NEGOCIADO DE ENERGÍA DE PUERTO RICO
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

approved the conversion of San Juan 5 and 6 to natural gas, including the associated five-year fuel contract.[266]

iii. Gas turbines

290. PREPA includes 743 MW of GTs in the Proposed IRP. As noted in Exhibit 4-5 of the Proposed IRP, all of the GTs currently operate on diesel fuel. The Proposed IRP models 24 units; Cambalache 1 (83 MW) is not included.[267] As noted earlier, Exhibit 4-2 of the Proposed IRP identifies the retirement of 378 MW of GTs through 2021. Section 4.2.1.3 of the Proposed IRP details the retirement of seven pairs of 2 × 21 MW or 294 MW of retirements early in the Proposed IRP Action Plan. The 378 MW represents all nine pairs of 2 × 21 MW GTs currently on the Island.

iv. Hydropower

291. PREPA includes 34 MW of operational hydropower in the Proposed IRP.[268] The 34 MW of operating hydropower is below the 105 MW nameplate capacity of the 11 hydropower facilities within Puerto Rico. PREPA notes that numerous units suffer from staffing and funding shortages.[269] As shown in Exhibit 4-10 of the Proposed IRP, PREPA assumes that 36 MW of the existing hydropower capacity is brought back as a new resource. This would bring the total hydro resource to 70 MW assumed in the Proposed IRP.

v. Power purchase and operating agreements

292. The Proposed IRP includes the EcoEléctrica PPOA for the 507 MW natural gas combined cycle plant.[270] PREPA also notes that it changed the modeling parameters of the plant to be more flexible in order to accommodate more renewables into the system.[271] In the ESM Scenario, PREPA assumes that the EcoEléctrica PPOA is renegotiated, and that the fixed payments are reduced going forward in 2022. Exhibit 4-12 of the Proposed IRP provides the modeled EcoEléctrica capacity payments in the ESM Scenario. In response to the ROI-10, PREPA provided additional information

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[266] Resolution and Order, In Re: Request for Proposals for Conversion of San Juan Units 5 & 6 to Natural Gas, Case No. CEPR-AI-2018-0001, January 25, 2019.

[267] *See* Proposed IRP, page 4-7.

[268] *Id.* at page 4-8.

[269] *Id.* at page 4-8.

[270] *Id.* at page 4-9.

[271] *Id.* at page 4-12.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

concerning the specific effects of the renegotiated contract parameters for the EcoEléctrica power plant.[272]

293. The Proposed IRP includes the AES PPOA for the 454 MW coal fired plant.[273] PREPA has an in-place PPOA with AES that runs through 2027. The Proposed IRP does not assume a renewal of the PPOA.

294. The Proposed IRP summarizes the status of the 68 renewable PPOAs signed between 2008 and 2012.[274] PREPA notes that, as of December 2018, 11 PPOAs are in operation or pre-operation that represent 272.9 MW in solar (147.1 MW), wind (121 MW), and landfill gas (4.8 MW).[275] PREPA notes that one wind project, Pattern Santa Isabel, is limited to 75 MW, even though the nameplate capacity for the project is 95 MW. The curtailment of the project is due to non-compliance with minimum technical requirements. PREPA used historical operations of the plants to determine modeled capacity factors for the plants in the Proposed IRP.

295. The Proposed IRP summarizes the 412.3 MW of solar PPOAs in renegotiation[276] and 795.4 MW of solar PPOAs not re-negotiated.[277] For the purposes of the Proposed IRP, PREPA modeled the identified capacity as "potential new supply sites with commercial conditions according to the PREPA forecast for new solar prices."[278] PREPA then notes that actual prices may deviate from the assumption based on legacy development and carrying costs attributable to delays.[279]

g. Environmental regulations

296. Exhibit 4-20 of the Proposed IRP summarizes PREPA's fossil generation units and corresponding environmental regulation obligations.[280] The Proposed IRP details the implications of the EPA's 2018 SO_2 attainment designations under the National Ambient Air Quality Standards (NAAQS).[281] The EPA has classified areas around San

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[272] Energy Bureau's ROI 10, December 13, 2019.

[273] *Id.* at page 4-12.

[274] *Id.* at page 4-14.

[275] The 121 MW includes the 26 MW Punta Lima wind project located in Naguabo. The wind farm suffered significant damage from Hurricane María and is currently not operational.

[276] *See* Proposed IRP, page 4-15.

[277] *Id.* at page 4-16.

[278] *Id.* at page 4-17.

[279] *Id*. at page 4-17.

[280] *Id.* at Exhibit 4-20.

[281] *Id.* at page 4-19.

Juan and Guayama-Salinas to be in non-attainment.[282] The non-attainment designations impact the San Juan (800 MW) and Palo Seco (728 MW) generating stations for the San Juan area, and impact the Aguirre (1,462 MW) generating facility. PREPA noted that the implicated plants will continue to monitor and report emissions, but do not have to alter operations at this time.[283] PREPA then notes that the results of the Proposed IRP modeling will impact the development of the Puerto Rico State Implementation Plan (SIP), and that some of the assumptions regarding the removal of Palo Seco 1 and 2 (170 MW) and two of the San Juan units (200 MW) will support SO_2 emissions reductions in the San Juan area.[284] Puerto Rico has until April 2023 to be in attainment for SO_2.[285]

297. The Proposed IRP describes PREPA's obligations under the MATS rule. Exhibit 4-25 of the Proposed IRP lists the existing units subject to the MATS rule.[286] These units include Aguirre 1 and 2; Costa Sur 3, 4, 5, and 6; Palo Seco 1, 2, 3, and 4; San Juan 7, 8, 9, and 10; and AES Coal Plant (not owned by PREPA). PREPA describes some of the strategies currently implemented to address compliance with MATS.[287] These include: limited operations of Aguirre 1 and 2 through 2025; operations of Costa Sur 5 and 6 using natural gas; exclusion of Costa Sur 3 and 4; exclusion of Palo Seco 1 and 2; and limited operations of two of the four San Juan units through 2025. PREPA also noted that it considered, but ultimately rejected, other options including fuel blending, and other operation adjustments (e.g., soot blowing, adjusting burn point temperatures, excess oxygen).

298. PREPA notes that there are currently no capital projects to address compliance with MATS or carbon regulations.[288] In a response to LEOs ROI 2-35, PREPA notes that the Proposed IRP assumed that the existing MATS affected units would be retired by 2025, therefore PREPA did not assume any associated consequences for MATs noncompliance through penalties or enforcement actions.[289]

299. PREPA documents current federal standards pertaining to cooling water intake and Puerto Rico water quality standards.[290] PREPA notes that current generating facilities

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[282] *Id.* at pages 4-19 to 4-20.

[283] *Id.* at page 4-21.

[284] *Id.* at page 4-22.

[285] *Id.* at page 4-25.

[286] *Id.* at pages 4-22 to 4-25.

[287] *Id.* at pages 4-24 to 4-25.

[288] *Id.* at, page 4-29.

[289] LEOs, ROI 2, August 26, 2019.

[290] *See* Proposed IRP, page 4-29.

all operate under site specific National Pollutant Discharge Elimination System (NPDES) permits.[291]

i. Act 17

300. PREPA's Proposed IRP notes the passage of Act 17.[292] Although PREPA does not provide a summary of the specific provisions of Act 17 in the Proposed IRP, the Proposed IRP references provisions of Act 17 in numerous locations throughout the document.[293]

301. Important provisions of Act 17 that impact this IRP are noted below:

- Section 1.5(5)(b) and Section 5.23 require that all existing and future units that generate power from fossil fuels to be capable of operating with at least two (2) types of fossil fuels, one of which shall be natural gas, to reduce greenhouse gas emissions and to increase the capacity of the electric power grid to integrate DG and renewable energy.
- Section 1.5(8)(c) and Section 1.12 promote the development of microgrids, particularly in essential service facilities as these are defined in Act 57, and in remote areas, as a mechanism to promote the resilience and modernization of the distribution networks.
- Section 1.6(3) and Section 4.11 outline the elimination of the use of coal as an energy source by not later than January 1, 2028.
- Section 1.6(7) and Section 4.2 require the reduction and eventual elimination of electric power generation from fossil fuels by integrating orderly and gradually alternative renewable energy while safeguarding the stability of the Electrical System and maximizing renewable energy resources in the short-, medium-, and long-term. For such purpose, a Renewable Portfolio Standard is established in order to achieve a minimum of twenty percent (20%) by 2022, forty percent (40%) on or before 2025; sixty percent (60%) on or before 2040; and one hundred percent (100%) on or before 2050.[294]
- Section 1.6(11) and Section 5.25 require attainment of the thirty percent (30%) energy efficiency goal by 2040, as provided in Act 57.
- Section 1.11(a) requires High Efficiency Electric Power Generation from Fossil and Diversified Fuel Mix. Every new or existing electric power plant, as of the date of approval of Act 57, other than those operating exclusively

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[291] *Id.* at page 4-29.

[292] *Id. at* page 2-5.

[293] *Id. at* pages 1-4, 1-9, 2-2, 2-5, 3-15, 4-12, 4-28, 4-29, 5-6, 6-3, 8-1, 8-15, 8-16, 8-18, 8-22, 8-45, 10-2, and 10-3.

[294] *See* Act 82, as amended,

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

on renewable energy sources shall have the capacity to generate power from two (2) or more fuels, one of which shall be natural gas, taking into account that, as of the approval of Act 57, the issuance of new permits and/or the award of new contracts to establish coal-fired power plants shall be prohibited, and no permit or amendment to an existing contract as of the approval of Act may authorize or consider coal burning as an energy source after January 1, 2028. At least sixty percent (60%) of the electric power generated from fossil fuels (gas or oil byproducts) shall be high efficiency, pursuant to Section 6.29(a) of Act 57. Contractors that acquire or operate PREPA assets related to generation shall modernize the electric power plants or replace them with high efficiency electric power plants within a period not to exceed five (5) years after the execution of the Partnership or Sales Contract. After this initial period, the contractor that opted for modernizing the electric power plants shall replace them with high efficiency power plants within a period not to exceed five (5) years after the initial period has ended. However, this shall not apply to the operators of legacy power generation assets.

- Section 1.15, in order to maximize the resources available for the reconstruction and modernization of the Electrical System, requires PREPA or the T&D network Contractor to ensure that the specific improvements to the Electrical System are carried out to render it robust, resilient, and stable in accordance with the modernization and reconstruction priorities established hereunder.

3. Intervenors

302. Several parties submitted testimony on PREPA's existing resources and PREPA's compliance with Federal environmental regulations. Comments regarding PREPA's compliance with Act 17 are detailed in Part III (D)Part III (E), and Part III (G).

a. AES Puerto Rico

303. AES expert witness, Mr. Ronald Moe, comments that the conversion of San Juan 5 & 6 appears to be a forced decision.295 In addition, Mr. Moe raises the issue that PREPA dropped the AES PPOA without considering converting the unit to run on natural gas.[296] Mr. Moe identifies three conversion options for the AES boilers: (1) conversion of the steam boilers to run on natural gas, (2) conversion to GTs with heat recovery steam generators that would increase the capacity to 585 MW, and (3) conversion of gas

[295] AES-PR, Direct Testimony of Ronald Moe, October 23, 2019, page 15.

[296] *Id.* at page 26.

turbine and utilization of pre-heated feedwater in the converted steam turbine that would increase the plant capacity to 642 MW.[297]

304. AES expert witness Ms. Kristina Lund comments on stranded cost risk of natural gas conversions occurring as a result of increasing penetration of renewable energy resources.[298] Specifically, she describes the scenario of a new natural gas plant being built in 2025 that may be unable to recover all of its costs before the Commonwealth reaches one hundred percent (100%) renewable by 2050, as natural gas generation steadily decreases with increasing renewable penetration.[299]

b. Local environmental organizations

305. In his testimony, LEOs' expert witness, Mr. Daniel Gutman, summarizes the air quality standards that PREPA must meet.[300] Specifically, Mr. Gutman notes the areas of violation of the sulfur dioxide (SO_2) NAAQS.[301] Mr. Gutman also notes the lack of air quality data collection and the reliance on computer modeling of air pollutants.[302]

306. Mr. Gutman notes that Aguirre, Costa Sur, San Juan, and Palo Seco plants are likely to be in violation of the 1-hour NAAQS limit for SO_2 of 196 micrograms per cubic meter, based on modeling results.[303] Mr. Gutman states that PREPA has three options to keep the plants running: (1) changing the sulfur content of the fuel oil burned at each plant; (2) installing emissions controls; and (3) reducing the maximum power generated.[304] Moreover, Mr. Gutman notes that the Aguirre and Palo Seco plants are currently operating below capacity and that pollution controls and/or switching to lower sulfur content fuels will be required to maintain compliance with air quality standards.[305]

307. The LEOs' brief cites 2011 Hazardous Air Pollutants (HAPs) emissions from the Aguirre power complex, and LEOs note that continued emissions from the plant increase HAPs concentrations in the area.[306] In its Reply Brief, LEOs contend that exposure to long-

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297 *Id.* at page 35.

298 AES-PR, Direct Testimony of Kristina Lund, October 23, 2019, page 14.

299 *Id*.

300 LEOs, Direct Testimony of Daniel Gutman, October 23, 2019, page 4.

301 *Id.* at page 6.

302 *Id.*

303 *Id.*

304 *Id.* at page 7.

305 *Id.* at page 8.

306 LEOs, Final Brief, March 6, 2020, Table 5, page 63.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

term air pollution exacerbates conditions contributing to the current COVID-19 pandemic.[307]

c. Not-for-profit intervenors

308. The NFPs' expert witness, Mr. José Alemán, notes that other than the values in Exhibit 4-10 and text in Section 4.2.1.4, the Proposed IRP does not contain any specific cost estimates for the overhaul and restoration of existing hydroelectric facilities.[308] Mr. Alemán recommends that PREPA should conduct an analysis to prioritize hydroelectric generation on the Island that would also include existing and non-operational sites.[309]

4. Discussion

309. The following details our findings on existing resources in the Proposed IRP by section of Regulation 9021.

310. Under Section 2.03(D)(1)(a), PREPA's IRP contained summary tables and descriptions of existing resources. The Energy Bureau **DETERMINES** that PREPA's description of the existing resources **complies** with Section 2.03(D)(1)(a).

311. Under Section 2.03(D)(1)(b), PREPA's Proposed IRP is required to provide supplemental information regarding PREPA's supply-side resources. The Energy Bureau **DETERMINES** that PREPA's description of the existing resources **complies** with Section 2.03(D)(1)(b).

312. Section 2.03(D)(1)(c) of Regulation 9021 requires PREPA to provide the following supplemental information: expected retirement date for any resource expected to retire within the first ten years of the Planning Period; dates of renewal for operating licenses and permits; compliance schedule with current, proposed, and reasonably anticipated regulatory and legal requirements; expected capital and operating costs for compliance with current, proposed, and reasonably anticipated regulatory and legal requirements; expected yearly non-environmental capital expenditures for the first ten years of the Planning Period; important changes to resources that have occurred since the approval of the 2015 IRP; and a description with quantitative information of how the resource contributes to meeting the requirement for "high efficiency" generation.

313. PREPA provides anticipated capital expenditures for 2019 and 2020, but PREPA does not provide the yearly capital expenditures in the body of the Proposed IRP anticipated

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[307] LEOs, Reply Brief, April 20, 2020, page 39.

[308] NFPs, Direct Testimony of José O. Alemán, October 22, 2019, page 5.

[309] *Id.* at page 11.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

for the following eight years, as required under Section 2.03(D)(1)(c).[310] The requirement provides useful information to assess the future economics of PREPA 's existing resources. The missing information could support future retirement schedules by identifying plants in need of major capital expenditures in the next ten years. The Energy Bureau therefore **DETERMINES** that PREPA's supplemental description of the existing resources **DOES NOT COMPLY** with Section 2.03(D)(1)(c). In the next IRP, the Energy Bureau **ORDERS** PREPA to comply with all requirements of Section 2.03(D)(1)(c).

314. The Energy Bureau notes that extenuating circumstances have impacted specific generation units during this proposed IRP process that have resulted in unanticipated changes to capital expenditures and expected retirement schedules. On January 6, 2020, a 5.8 magnitude earthquake struck the southwestern coast of Puerto Rico.[311] On January 7, 2020, a 6.4 magnitude earthquake struck in the same area, damaging areas around Ponce, including the Costa Sur power plant. The resulting damage to the Costa Sur power plant has shut down power generation at the facility. In a separate proceeding, PREPA petitioned the Energy Bureau to approve a plan to repair Costa Sur Unit 5 using predominantly FEMA funding so that the unit can return to service for the summer of 2020 to meet expected demand.[312] On May 22, 2020, the Energy Bureau issued a Resolution and Order approving the emergency repair work with conditions on the total amount of spending, additional reporting requirements, and demand-side management requirements.[313]

315. On the issue of expected environmental compliance costs, PREPA notes that there were no current capital projects planned to address MATS or carbon regulation.[314] PREPA then states that the planned transformation of the PREPA supply fleet will contribute to PREPA's ability to reach and maintain fleet-wide environmental compliance.[315] In response to EDF ROI 1-15, PREPA provides a description of the units affected by MATS and PREPA's current compliance that supplements PREPA's Exhibit 4-25.[316] PREPA's MATS compliance consists of process changes and/or fuel switching strategies while it negotiates with EPA and the Department of Justice to develop and implement a more

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310 Annual fixed costs for PREPA's resources are provided in the supporting metrics files for each of the analyzed cases modeled by PREPA. However, detailed projected annual capital expenditures by unit are not provided or summarized.

311 https://www.usgs.gov/news/magnitude-64-earthquake-puerto-rico.

312 PREPA, Motion to Inform, March 31, 2020, NEPR-AP-2020-0001.

313 Resolution and Order, In Re: Request for Proposals for Temporary Emergency Generation, Case No. NEPR-AP-2020-000, May 22, 2020, pages 13 and 14.

314 *See* Proposed IRP, page 4-26.

315 *Id.* at page 4-26.

316 EDF, ROI 1-15, received October 4, 2019.

extensive Clean Air Act compliance program.[317] The transformation of PREPA existing generation fleet will continue as renewable generation penetration increases and existing generation resources retire. The Energy Bureau sees merit in PREPA's implementation of temporary process and fuel switching for units that will eventually be retired.

316. For cooling water intake and water quality standards, PREPA merely states that new facilities will be required to comply with current requirements.[318] PREPA does not provide any separate estimate of Clean Water Act or Puerto Rico Water Quality Standards Regulation compliance costs for any of the proposed new resources in the Proposed IRP. The Proposed IRP is not clear if PREPA's new generation resources' capital costs for representative new resource candidates shown in Exhibit 6-15 embeds future environmental compliance costs for new resources.

317. In Parts III(G),(H) and the Approved Action Plan, the Energy Bureau addresses a plan for renewable energy in order to meet the one-hundred percent (100%) renewable energy goal by 2050 as required by Act 17.

318. Section 2.03(D)(1)(c) also requires PREPA to provide supplemental information on important changes to resources that have occurred since the approval of the 2015 IRP. The Proposed IRP provides a broad summary of changes in laws and regulations; the 2017 hurricanes; changes in solar and energy storage costs; the Puerto Rico Oversight, Management and Economic Stability Act (PROMESA); and the FOMB. However, a detailed summary of changes to PREPA's existing resources is not summarized. For example, PREPA's conversion of San Juan Units 5 and 6 to burn natural gas is discussed throughout the IRP, but it is not flagged as a change from the 2015 IRP. Another example is the anticipated termination of the AES power purchase agreement in 2027 as a result of Act 17.

319. Under Section 2.03(D)(1)(c), PREPA's Proposed IRP is required to provide supplemental information regarding PREPA's supply-side resources. As noted in the preceding paragraphs, PREPA has not provided all of the elements required under Section 2.03(D)(1)(c). PREPA has failed to provide annual anticipated non-environmental capital expenditures for the next 10 years. PREPA has identified how environmental regulations affected new resources, however PREPA does not provide the expected capital and operating costs for compliance with current, proposed, and reasonably anticipated regulatory and legal requirements. Finally, PREPA has not summarized supplemental information on important changes to resources that have occurred since the approval of the most recent IRP.

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[317] *Id.*

[318] *See* Proposed IRP, pages 4-29 and 4-30.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

320. The Energy Bureau **DETERMINES** that PREPA's supplemental description of the existing resources **DOES NOT COMPLY** with Section 2.03(D)(1)(c). In the next IRP, the Energy Bureau **ORDERS** PREPA to comply with all requirements of Section 2.03(D)(1)(c).

D. Resource Needs Assessment

321. Regulation 9021[319] requires PREPA to assess its expected PRM.[320] PREPA must prepare a table showing its existing capacity resources and expected load requirements, including the PRM, and identify its "annual net position"[321] relative to expected needs. The Proposed IRP was ruled complete with the recognition that PREPA had included the information available to directly assess actual PRM based on existing unit information and load forecast information, and had included information available to directly assess the annual net position.[322] PREPA did not, however, explicitly include a table of such projected PRM for existing resources only, nor did it explicitly identify its "annual net position" prior to developing new resources.

1. PREPA Filing

322. PREPA presented Part 5 of the Proposed IRP as a "Resource Needs Assessment." In summary form in Part 1, and in Part 5, PREPA describes its approach to assessing resource needs. Part 5 discusses PREPA's overview of resource needs from PREPA's perspective; PREPA's asserts that, the "IRP is not a classical IRP that identifies the least cost approach to address the expected gap between load and resources and maintaining a desired Planning Reserve Margin," but instead serves customer-centric metrics.[323] PREPA's Exhibit 5-4 lists in summary form the units included as IRP resources, and additional tables and text in Part 4 of its IRP ("Existing Resources")

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[319] *See* Regulation 9021 §§ 2.03 (E)(1) and (2).

[320] The PRM is in general the amount of capacity available above peak load requirements during the time of peak load. It is usually expressed as a percentage of peak load. A minimum or threshold requirement for a PRM is usually defined as the level of capacity above peak load that is required in order to ensure reliable operations, based on a specific loss-of-load metric. Actual PRM is often or usually different from the specific minimum or threshold PRM requirement. If it is greater than the minimum threshold, there is surplus capacity; if it is less, there is a shortage of capacity.

[321] Annual net position refers to the MW quantity of capacity that PREPA is short (shortage) or long (surplus), relative to capacity needed to cover both peak load and the minimum PRM requirement.

[322] Resolution and Order, In Re: Integrated Resource Plan for the Puerto Rico Electric Power Authority, Case No. CEPR-AP-2018-0001, July 3, 2019.

[323] *See* Proposed IRP, pages 5-3 and 1-2. PREPA describes its customer-centric "pillar" on page 1-1 to include "customer participation via energy efficiency, customer side energy resources and DR with a predominant role in the supply and consumption matrix of Puerto Rico, and empowering customers to participate and take ownership on their energy security and affordability."

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

contain further detail on existing units. Table 3 reproduces the set of existing PREPA resources modeled in the IRP, in summary form.

323. PREPA describes three strategies that it presented for consideration as part of the stakeholder process: Strategy 1, centralized energy program; Strategy 2, distributed system of flexible generation, and micro or mini-grids and hardening of existing infrastructure around Puerto Rico (emphasizing resiliency and customer proximity); and Strategy 3, reflecting a hybrid of Strategy 1 and Strategy 2.

324. Those three strategies formed the basis for key modeling parameterization used in the resource development process.[324] PREPA also describes use of the MiniGrid construct across all three Strategies wherein 100% of critical loads are served by thermal resources during a MiniGrid event.[325] PREPA notes that stakeholders "generally reached consensus" on a strategy founded on distributed rather than centralized supply resources being more appropriate to Puerto Rico "because it provides a more resilient grid."[326]

325. PREPA outlines in Exhibit 5-2 of the Proposed IRP the six Scenarios it considered in its modeling executions (Scenarios 1 through 5, and the ESM Scenario). PREPA describes the Scenario 1 through Scenario 5 definitions, which generally reflect gas availability across the Island for generation resource development options.[327] The ESM Scenario is also described, noting that "fixed resource" decisions are included in the ESM Scenario, *i.e.* selections that were not subject to optimization using the LTCE engine of the Aurora modeling framework.[328] PREPA notes its provision of a filed workpaper, "Considerations on the ESM Plan," which describes the elements of the ESM plan and why PREPA believes it reasonable to include such elements in a Preferred Resource Plan. PREPA also describes the general nature of conditions and assumptions modeled across all plans, including the load levels, EE assumptions, contract resources (*e.g.*, AES coal plant and the EcoEléctrica gas plant), fuel forecasts, renewable energy costs, and choice of additional peaking generation added to modeling runs with Strategy 2 or

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[324] PREPA Response to Energy Bureau ROI 1-7, indicating a local reserve requirement of eighty percent (80%) was used for Strategy 2 (1-7 a), fifty percent (50%) for Strategy 3 (1-7 b), and that all "critical load" is served by thermal generation (1-7 e). The local reserve requirement is a model parameter, or input assumption, that has direct bearing on the amount of capacity required in any optimal resource plan.

[325] PREPA Response to Energy Bureau ROI 1-7 e). A MiniGrid event is an extreme weather event, such as a hurricane, that leads to loss of interconnected transmission lines and isolation of the different sections of the Island's power system.

[326] *See* Proposed IRP, page 5-3.

[327] The Scenarios are described in more detail in Part II(B)of this Final Resolution and Order.

[328] The Aurora modeling framework is used by PREPA to conduct the economic optimizations required for the evaluated resource plans. It is a complex commercial software package used by various utilities in the US for resource planning purposes. A filed workpaper discusses the modeling construct in some detail.

Strategy 3 to reflect "critical load" service under a MiniGrid construct following a mini-grid event.

326. PREPA then describes how sensitivities are applied in its modeling exercise and defines the nine sensitivities tested at the time of the filing (additional sensitivity runs were later added in response to Requirements of Information from the Energy Bureau). The sensitivities generally reflect variations in fuel price, resource cost, resource availability, EE level, and ship-based gas provision allowance in San Juan. Exhibit 5-3 of the Proposed IRP shows how the sensitivities are executed across different Scenarios. PREPA notes that other sensitivities were considered and provides a rationale for why some were not included.[329]

327. PREPA further notes that additional sensitivities could be included, including CO_2 emission prices, but they were not considered in the initial sets of modeling runs. The Energy Bureau ROI 6-3 did ask for a limited sensitivity on carbon pricing, following discussion at the August technical conference.[330]

328. PREPA also provided further information at the hearing in response to questions concerning the comparative effect of a carbon price sensitivity applied to existing resource plans: the ESM Scenario and Scenario 3. This information, based on the responses of Mr. Sáenz, indicated a larger carbon cost would be present in the ESM Scenario compared to Scenario 3 in 2025 (for example) if a value on carbon emissions was explicitly factored in to the analyses, since the ESM Scenario (baseload) exhibited a larger carbon emission level in 2025 than the Scenario S3S2B.[331]

a. Planning reserve margin assessment

329. A PRM is a level of capacity reserves above that needed to meet peak load requirements. Unexpected equipment outages and load forecast deviations result in a need to

329 *See* Proposed IRP, page 5-7.

330 Energy Bureau's ROI 6-3, "Carbon Adder sensitivity." This sensitivity request included LTCE modeling runs for three Scenarios, S4S2, S3S2, and the ESM scenario. These modeling runs resulted in resource plan changes – *e.g.*, additional solar PV, and earlier retirement of the AES plant – and the effect of these runs on NPV must be carefully considered before drawing any comprehensive conclusions as to the effect of a carbon adder. In essence, these three modeling runs stand apart from any other modeling run in the Proposed IRP because of the changed input assumption and resulting resource build/retirement patterns. Additional discussion is contained in Part III(G) on Resource Development addressing the effect of carbon emissions on resource planning.

331 Evidentiary Hearing, February 6, morning session, 01:25.

maintain a PRM in order to ensure reliable operations.[332] PREPA has stated that 30% is an adequate PRM requirement.[333]

330. PREPA provides a separate Section 8.7 on "Planning Reserve Margin Considerations." PREPA states the purpose of the section is to discuss the PRM in more depth. PREPA notes that a PRM of 30% (*i.e.*, 30% more MW capacity than the MW peak load level) was "found to be adequate on earlier resource sufficiency assessments."[334] PREPA notes that if the PRM is a binding constraint, it indicates that new peaking resources are built in response to low reserve levels.[335] PREPA states that for its preferred portfolios, S4S2 and ESM, PRM was never a binding constraint.[336] This determination is due to increased local capacity reserve requirements (80% for Strategy 2, 50% for Strategy 3, and mandated thermal capacity to meet critical loads) superseding the minimum requirement applicable for all of Puerto Rico. PREPA proceeds, in this section, to describe the results of a series of scenarios in which the reserve margin was close to the PRM of thirty percent (30%), and peaking units were generally built in those scenarios in later years.

b. Load and resource balance

331. PREPA does not present a classical or conventional load and resource balance table associated with existing resources and its existing load forecast in the main body of Proposed IRP. Nevertheless, PREPA does provide reserve margins for modeled scenarios in its "metrics" files workpapers.[337]

332. In response to the Energy Bureau's ROI 1-7, PREPA provided PRM computations for four key scenarios, in one file. Table 2 below summarizes PREPA's reserve margins over time for those four scenarios.

Table 2. PREPA Island-Wide Planning Reserve Margins – Scenarios S1S2, ESM, S4S2, S3S2 – Base Load with Full EE

Scenario	2019	2020	2025	2030	2035	2036	2037	2038
S4S2B	71%	53%	69%	48%	67%	70%	74%	69%
S3S2B	86%	70%	48%	82%	99%	114%	130%	133%

[332] PREPA states its criteria is no more than four loss-of-load hours per year; *see P*roposed IRP Section 8.7, page 8-89.

[333] *See* Proposed IRP, Section 8.7, page 8-89 and page 8-91.

[334] *See* Proposed IRP, Section 8.7, page 8-89.

[335] *Id.*

[336] *Id.*

[337] All metrics files (*i.e.*, all modeled Scenarios) provide a measure of PRM based on "night peak" in the "metrics detail" tab.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Scenario	2019	2020	2025	2030	2035	2036	2037	2038
S1S2B	68%	40%	49%	44%	45%	37%	40%	52%
ESM	71%	53%	78%	78%	97%	95%	100%	95%
MinThresh30%	30%	30%	30%	30%	30%	30%	30%	30%
_50%	50%	50%	50%	50%	50%	50%	50%	50%

Source: PREPA's Response to Energy Bureau's ROI 1-7, Attachment 1.

2. Intervenors

a. Environmental Defense Fund

333. EDF notes that PREPA's resource plan "was overly reliant on centralized gas plants and produced an excessive [one hundred percent (100%)] reserve margin".[338] EDF further notes that dividing the Island into eight MiniGrids and applying local resource constraints and a need for thermal generation to serve critical load results in a high reserve margin. EDF in its recommendations suggests that the Energy Bureau approve just one MiniGrid, including the amount of reserve to apply for that MiniGrid.[339] EDF also suggests that PREPA obtain the Energy Bureau's approval for the reserve margin requirement prior to the next IRP.[340]

b. Local environmental organizations

334. Ms. Sommer, LEOs expert witness, testifies to the reserve margin considerations in PREPA's filing. She notes the high reserve margins associated with a number of PREPA's scenarios. She asserts that high reserve margins are generally associated with higher costs. She references PREPA's Proposed IRP Section 8.7 and states that the fact that PREPA's thirty percent (30%) reserve margin that is not binding is not sufficient information, – and that it is important to understand why the reserve margins in the Scenarios run by PREPA are so high. She states that there might be two possible reasons for the high reserve margins: the way in which loss of load is considered in the model; and the way in which forced outage rates are reflected in PREPA's modeling.[341]

335. LEOs reiterate their concern with PREPA's high reserve margin in their Final Brief, with witness Ms. Sommers noting the high reserve margins that result with Scenario S4S2 (50% to 90%) and the ESM Scenario (60%-100%). LEOs also note that the Energy

[338] EDF, Final Brief, page 1. March 6, 2020.

[339] *Id.* at pages 26 and 50.

[340] *Id.* at page 52.

[341] LEOs, Direct Testimony of Anna Sommer, pages 19-20.

Bureau's Order on Evidentiary Format raised the possibility that the MiniGrid vision may be having on impact on the reserve requirements.[342]

c. Other intervenors

336. The remaining intervenors did not provide testimony or discuss in Final Briefs PREPA's resource need in the context of Regulation 9021's requirement that a load and resource balance table be provided, that a PRM assessment be included, and an "annual net position" be described.

3. Discussion

337. Independent of PREPA's characterization of resource need or requirements in the context of resiliency concerns – *i.e.*, its MiniGrid construct[343] – it is critical to establish a forward-looking resource outlook to reflect the Island's current system as an integrated whole. Considering only PREPA's modeled resource scenarios (ESM, S4S2, S3S2, etc.) masks an overall picture of resource and load balance in Puerto Rico, because those scenarios: i) include proposed new resource installations; and ii) are premised on a modeling foundation that imposes additional reserve requirements on the system. The additional reserve requirements are those in excess of required island-wide resource sufficiency as expressed by PREPA, namely a 30% reserve margin.[344]

338. An existing system capacity balance serves as a useful starting point to assess resource need.

339. Regulation 9021 requires provision of a load and resource balance table for such existing conditions, inclusive of resource requirements considering a PRM in addition to a peak load forecast.[345] Regulation 9021 also requires identification of an "annual net position" relative to expected needs. Proposed IRP Section 5 as filed by PREPA does not directly provide an annual load and resource balance table for existing conditions, nor does it provide an "annual net position" under any set of resource or load

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342 LEOs, Final Brief, page 23.

343 *See* Proposed IRP, Appendix 1: Transmission and Distribution, Section 2, describes PREPA's MiniGrid approach. Specific to resource need, PREPA states that its design consists in part of an overarching activity, "the generation resource selection to ensure that the MiniGrid will have local resources adequate to serve its load in isolation…" (Page 2.4), and that "critical loads must be served by thermal resources only…"(Page 2-6), and that "The installed capacity considering the storage and the thermal must be enough to cover the coincident peak load of critical and priority loads." (Page 2-6). Part III(I) of this Final Resolution and Order addresses the MiniGrid construct in further detail.

344 *See* Proposed IRP, Section 8.7.

345 *See* Regulation 9021, Section 2.03 (E) (2).

combinations. The Energy Bureau **ORDERS** PREPA to provide these two elements in the body of its next IRP filing, with supporting data contained in workpapers.

340. Notwithstanding the foregoing, the readily available generation fleet data from PREPA's filing, and its load forecasts—the original three "base", "high", and "low" forecasts, all with "full EE"; and the two revised forecasts[346]—allow for derivation of foundational load and resource balances. Table 3 below lists the existing resources on PREPA's system (seen in PREPA's Exhibit 4-5) that provide capacity during the nighttime peak load.[347] Table 4, which follows, shows the total of night peak capacity, the five load forecasts, and five resulting reserve margin trajectories, for the existing resource base.

Table 3. PREPA Existing and Contracted Resources with "Night Peak" Capacity Provision, MW

Station or Unit	Fuel	2019	2020	2021	2025	2030	2038
AES_1	Coal	227	227	227	227	208	208
AES_2	Coal	227	227	227	227	208	208
EcoEléctrica	Gas	507	507	507	507	507	507
COSTA SUR 5	Gas	388	388	388	388	388	388
COSTA SUR 6	Gas	393	393	393	393	393	393
SAN JUAN 5 & 6 CC - Diesel	Diesel	197					
San Juan 5 & 6 Converted CC	Gas		400	400	400	400	400
AGUIRRE STEAM_1	HFO	432	432	432	432	432	432
AGUIRRE STEAM_2	HFO	429	429	429	429	429	429
AGUIRRE 1 CC	Diesel	257	257	257	257	257	257
AGUIRRE 2 CC	Diesel	249	249	249	249	249	249
SAN JUAN 7 & 8	HFO	189	189	189	189	189	189
PALO SECO 3 & 4	HFO	413	413	413	413	413	413
MAYAGÜEZ GT 1, 2, 3, and 4	GT-oil	200	200	200	200	200	200
CAMBALACHE CT_3 and CT_2	GT-oil	165	165	165	165	165	165
PALO SECO CT11, CT12, CT31	GT_old-oil	126	126	126	126	126	126
DAGUAO GT11 & GT12	GT_old-oil	42	42	42	42	42	42
YABUCOA GT11 & GT12	GT_old-oil	42	42	42	42	42	42
Jobos GT11 & GT12	GT_old-oil	42	42	42	42	42	42
Vega Baja GT11 & GT12	GT_old-oil	42	42	42	42	42	42

[346] With lower EE assumptions. *See* the response to ROI 9-1 for Low EE and No EE forecasts under the original baseload case.

[347] PREPA references this component of total installed capacity in its metrics files, as "Night Peak Capacity (MW)".

Station or Unit	Fuel	2019	2020	2021	2025	2030	2038
Aguirre GT21 & GT22	GT_old-oil	42	42	42	42	42	42
Costa Sur GT11 & GT12	GT_old-oil	42	42	42	42	42	42
Landfill Gas (Fajardo + Toa Baja)	LFG	5	5	5	5	5	5
PREPA Hydro (Yauco, Dos Bocas, Caonillas, Río Blanco)	Hydro	33	52	70	70	70	70
Total Night Peak Capacity (MW)		**4,690**	**4,911**	**4,929**	**4,929**	**4,892**	**4,892**

Notes: 1- Excludes any CHP. 2- Assumes 2020 capacity from converted San Juan 5&6 at full level throughout period. 3 – Assumes PREPA ramp of existing hydro capacity from 33 MW to 70 MW. Excludes any new additions and includes all other resources. 4 – For PREPA thermal resources, reflects MW capacity less than maximum modeled capacity as seen in Exhibit 4-5. Source: adapted from PREPA's resource base as listed in the "metrics detail" tab of its S4S2 metrics file.

Table 4. Total Peak Load Serving Existing Capacity, Peak Load Forecast, and Computed Reserve Margin

Night Peak Capacity	**2019**	**2020**	**2021**		**2025**	**2030**		**2038**
Capacity Total, MW	4,690	4,911	4,929		4,929	4,892		4,892
Night Peak Load Forecast	**2019**	**2020**	**2021**		**2025**	**2030**		**2038**
Low	2,575	2,487	2,416		2,188	1,899		1,609
Base	2,660	2,598	2,555		2,385	2,101		1,769
High	2,752	2,722	2,696		2,599	2,349		2,017
Base Low EE	2,692	2,675	2,664		2,597	2,448		2,345
Base No EE	2,720	2,726	2,736		2,753	2,674		2,590
Reserve Margin								
Load Forecast	**2019**	**2020**	**2021**		**2025**	**2030**		**2038**
Low	82%	97%	104%		125%	158%		204%
Base Full EE	76%	89%	93%		107%	133%		177%
High	70%	80%	83%		90%	108%		143%
Base Low EE	74%	84%	85%		90%	100%		109%
Base No EE	72%	80%	80%		79%	83%		89%
Threshold PRM	30%	30%	30%		30%	30%		30%

Notes: 1- Reserve margin computed directly as (Night Capacity-Peak)/Peak. Resources as seen in Table 1. 2 – Load forecast includes T&D system losses, i.e., these values reflect total output at generators at the peak period. Source: PREPA peak load forecast from metrics files.

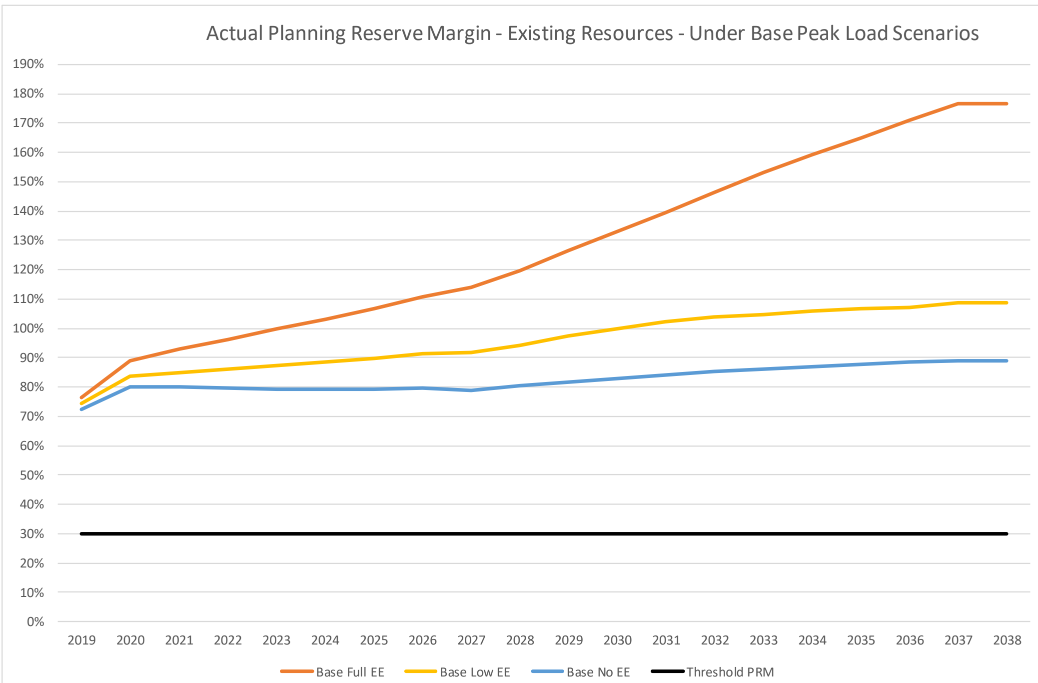
341. Table 4 above shows a range of potential reserve margin assuming full availability of PREPA's resources, under varying trajectories of forecast peak load.

342. Figure 1 below incorporates PREPA's existing unit data (as seen in Table 3) and shows the PRM for the full existing fleet, under three different projections of peak load, for

2019-2038, reflecting PREPA's base forecast with no EE, low levels of EE, and full levels of EE reflecting the current requirements.[348]

343. As seen, the electric power system's overall PRMs in all three baseload cases (*i.e.*, baseload forecast with three different levels of applied EE) remain high, when counting all of the existing capacity and prior to considering availability and potential retirement, closure, or contract cessation for some resources.[349] For the baseload projection with full EE, the PRM steadily increases, to well over 100% and reaching 160% by 2034. The highest load forecast, with no incremental EE, leads to reserve margins of 89% at the end of the period.

Figure 1. PREPA Planning Reserve Margin With Existing Resources and Forecast Peak Load, 2019-2038



Source: PREPA existing resources from S4S2 metrics file, excluding all new additions, and assuming no retirement of any units. "Night Peak capacity" values from "metrics detail" tab of metrics file. Assumes full availability of all units in PREPA's Proposed IRP, Exhibit 4-5.

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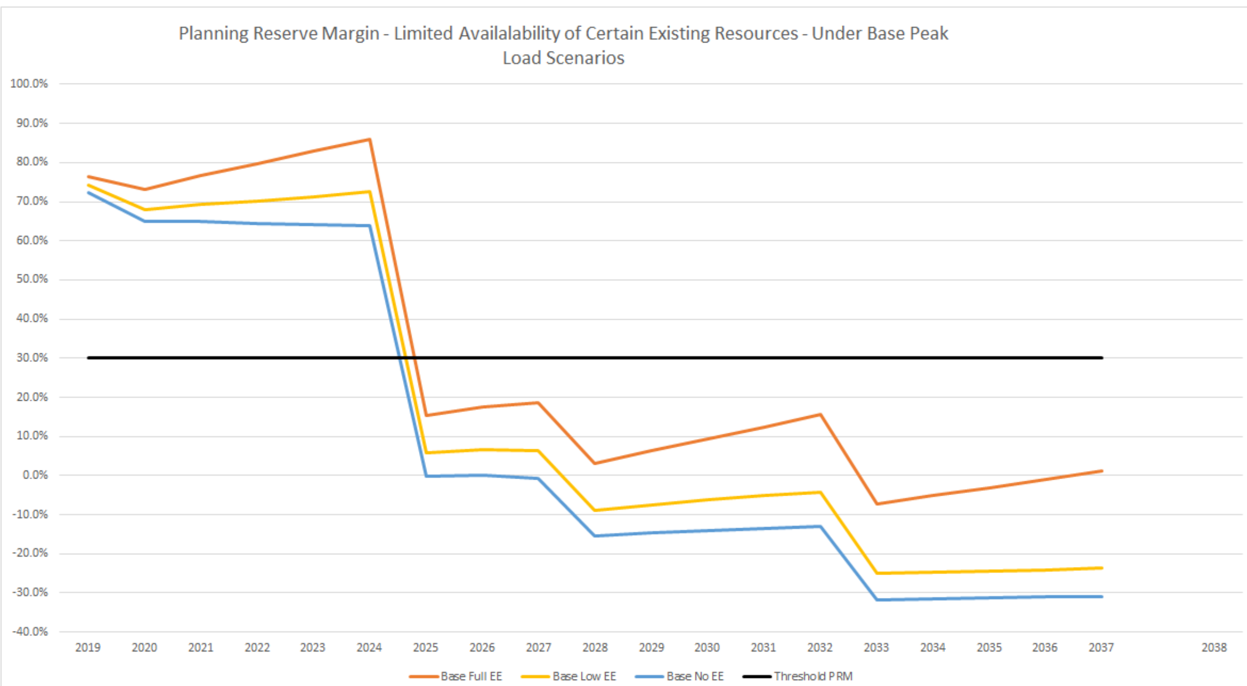
[348] Current requirements are those incorporated in Article 6.29B of Act 57, which requires a thirty percent (30%) improvement in energy efficiency by 2040.

[349] Exhibit 4-5, "PREPA Existing Units Included in the IRP", indicates a total of 5,010 MW of "Maximum Modeled Capacity (MW)". It includes 2 of the four San Juan steam units (7 through 10), all 378 MW of older gas turbine (diesel oil-fired) units spread across seven locations in Puerto Rico, and remaining units at Aguirre (2 steam and 2 combined cycle), Costa Sur (2 gas-fired steam units, 5&6) and Palo Seco (steam units 3 and 4). It also includes the newly-converting San Juan units 5 and 6 (Combined Cycle), peaking facilities at Mayagüez and Cambalache, Hydro units (initially at a derated 34 MW total, rising to 70 MW by 2021), and contract capacity at the AES coal plant and the EcoEléctrica gas plant.

344. Given the degraded conditions at many power plants,[350] however, and the MATS-regulation-driven limitations that may result in the near-term retirement of some of the older steam units (*e.g.*, at Aguirre, Palo Seco, and San Juan), it is useful—and presents a more realistic reserve margin depiction for existing resources—to develop a modified resource/load balance graph. That graph illustrates the nature of the PRMs that exist or will soon exist on Puerto Rico with different configurations of "existing" resources under the different load forecasts, essentially reflecting retirement or closure or contract cessation.

345. Figure 2 below illustrates PRMs on the system assuming that: (i) all MATS-impacted units retire by the end of 2024 (Aguirre 1&2, Palo Seco 3&4, San Juan 7&8); (ii) Aguirre CC units 1 & 2 retire by the end of 2024; (iii) that roughly half of the older GT units are not available as of 2020; and (iv) that Costa Sur 5&6 are returned to service, AES closes at the end of 2027, and the EcoEléctrica contract is not renewed after 2032.[351]

Figure 2. Planning Reserve Margins Under Limited Availability of Certain Existing Resources



Source and Notes: Response to ROI 9-2, Attachment 2, reflects availability of 10 of the 18 "old GT" units. The graph above reflects availability for 9 of 18 units, or one-half of the 378 MW total (i.e., 188 MW). Costa Sur 5&6 assumed available; AES and

[350] PREPA Response to Energy Bureau's ROI 9-2 indicates that only roughly half of the 378 MW of older GTs are available. Costa Sur 5&6 were not available as of July 2020 due to the earthquakes in early 2020, but are assumed back in service this year. Relatively high outage rates at the older steam plants also limit their availability, beyond regulation-driven limitations. The hydro facilities are currently rated at 34 MW, below their 105 MW nameplate rating (see Proposed IRP, page 4-8).

[351] Under any circumstance in which Costa Sur 5, and/or Costa Sur 6 is retired, and AES or EcoEléctrica capacity is retained past 2027 and 2032 (respectively), the reserve margins shown in this graph will change accordingly.

EcoEléctrica assumed not available after 2027 and 2032. No new capacity additions reflected. San Juan 5&6 (newly converted) assumed available in 2020 at 400 MW total.

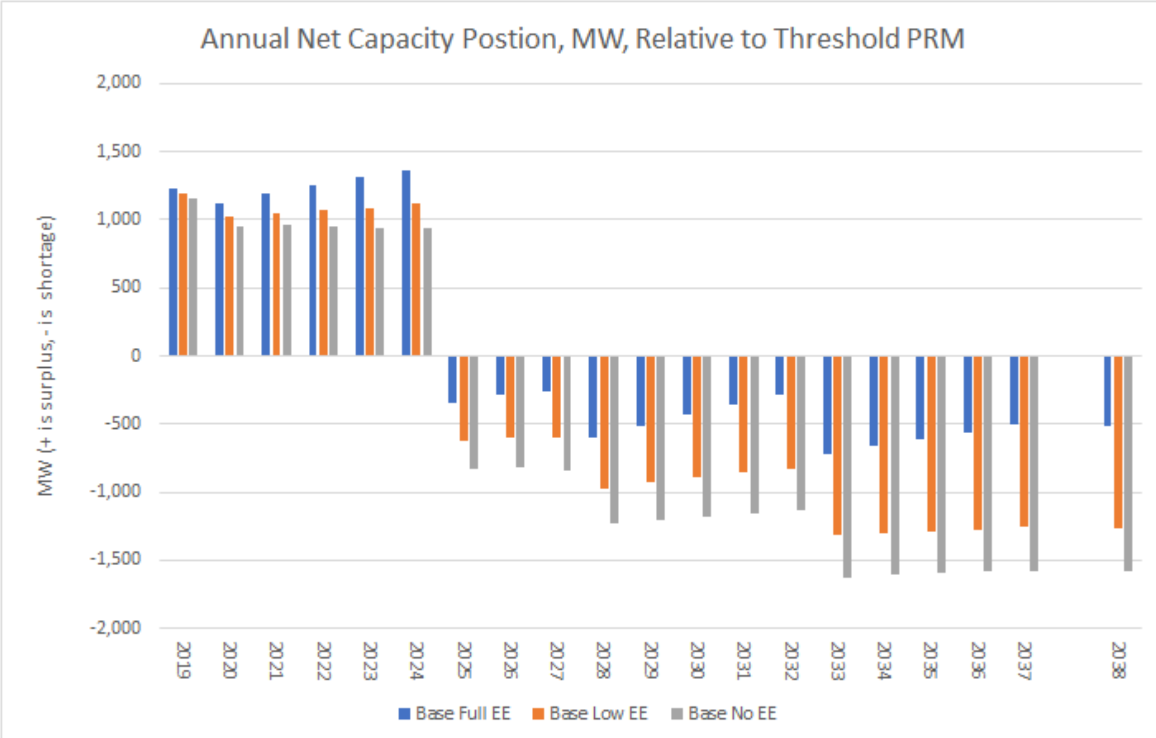
346. In this illustration several observations are useful:

- First, assuming reduced availability of the older gas turbine units in 2020, and including the capacity at Costa Sur units 5 and 6, the reserve margin is maintained at a relatively high level above the minimum reserve requirement threshold for all load forecasts seen for the pending Action Plan period through 2024. This assumes full availability of the newly-converting (to gas-fired combined cycle) San Juan units 5 and 6.[352]
- Second, upon onset of any MATS-regulation-caused closure of the steam plants and combined cycle units at Aguirre, Palo Seco and San Juan, seen in 2025, the reserve margin dips below required thresholds.
- Third, it can be inferred that considering use of some MATS-impacted units beyond 2024 would allow for continuing maintenance of a PRM above the threshold; however, the more EE that is incorporated into the scenarios, the less MATS-impacted units would be needed to maintain the PRM above the threshold.
- Fourth, it is readily surmised that increases in capacity through new additions prior to 2024 – e.g., new battery storage resources of sufficient duration, as chosen in essentially all of PREPA's modeled scenarios – will tend to improve the otherwise-deficient post-2024 margin. The level of improvement will depend on the level of capacity procured.
- The outer years of the planning horizon reflect the effect of contract cessation and capacity loss of the AES and the EcoEléctrica plants. Retention of EcoEléctrica, or retention of AES capacity if it were repowered with gas would increase the PRM shown in this graph in those outer years.
- Last, the graph reflects an island-wide capacity position, prior to any considerations of potential increased local capacity requirements whose imposition would change the "threshold PRM" margin shown in the graph.

347. PREPA's "annual net position"— *i.e.*, the amount of capacity (surplus or shortage) relative to the threshold PRM—is readily derived from PREPA's resources and load forecast data. Figure 3 below shows a range of the annual net position for the PRM circumstance illustrated above in Figure 2, for the three different "base" peak load forecasts.

[352] PREPA indicated completion is expected for those units by the middle of June 2020. Evidentiary Hearing, Testimony of Alfonso Baretty-Huertas, February 3, 2020, morning session, 02:01.

Figure 3. PREPA Annual Net Position, MW, Existing Resource Base with Projected Closures, Retirements, and Reduced Availability



Source: Synapse computation of annual net position using PREPA existing resources, less capacity reductions seen in Figure 2__ above, and relative to PRM reflecting a 30% reserve margin and the load forecast shown in Table 4 above.

348. Figure 3 above illustrates the range of capacity need PREPA faces given its load forecast outlook, and its existing resource base. The following observations can be made:

- Directly accounting for reduced availability of older GTs, and assuming in service the capacity at Costa Sur 5&6, leads to a reasonably comfortable reserve margin, above the minimum threshold requirement over the next five years. Practically speaking, this illustrates the importance of maintaining either the in-service capability of Costa Sur units 5 and 6, or maintenance on other units until new capacity is available, and it indicates the importance of rapidly procuring any "no regrets" capacity that would be part of an approved Action Plan, especially battery resources and any peak load reductions available from EE and DR resources.[353] To the extent that Costa Sur 5&6 were not available, the surpluses seen in the early years would decrease and the shortages shown in later years would increase.
- As long as the capacity available at Costa Sur 5&6 remains, there is sufficient headroom for PREPA to commence consideration of retirement planning

[353] As noted by Dr. Bacalao, battery capacity also has the additional benefit of dispatchability, reducing spinning reserve required from thermal units. Evidentiary Hearing, February 6, morning session, circa 00:30 and 02:26.

for the older MATS-impacted steam and oil-fired combined cycle units. The Energy Bureau's Modified Action Plan addresses the timeline and compliance reporting for such retirements.

- The effect of the potential loss of capacity from the AES and EcoEléctrica plants is seen in the change of annual net position in 2028 and 2033.
- Over the near and longer term, peak load reductions from EE resources can help to increase the surplus, and shrink the shortage, for any given year.

349. Under all of PREPA's resource scenarios, new capacity is built in the LTCE runs as existing capacity resources retire.[354] For the purpose of assessing how PREPA's annual net position with respect to capacity need changes as new resources are brought online, it is useful to test the effect of these resource additions.

350. Since battery resource installation is common to all scenarios and provides firm capacity (unlike solar PV, absent storage), and is essentially required to prevent curtailment of solar PV resources needed to meet RPS requirements, it is useful to see battery installation impact on PREPA's annual net position. The following figures show how the annual net position changes: under three different load scenarios; for battery installation associated with the original S4S2 Scenario; and for the less-restricted solar PV installation Scenario S3S2. The following figures show the capacity "headroom" above minimum requirements when considering only battery installations, separate from any consideration of new gas-fired generation (peaking resources or combined cycle units).

[354] *See*, *e.g.*, Proposed IRP, Exhibit 8-1; and PREPA responses to Energy Bureau's ROI 10-5.

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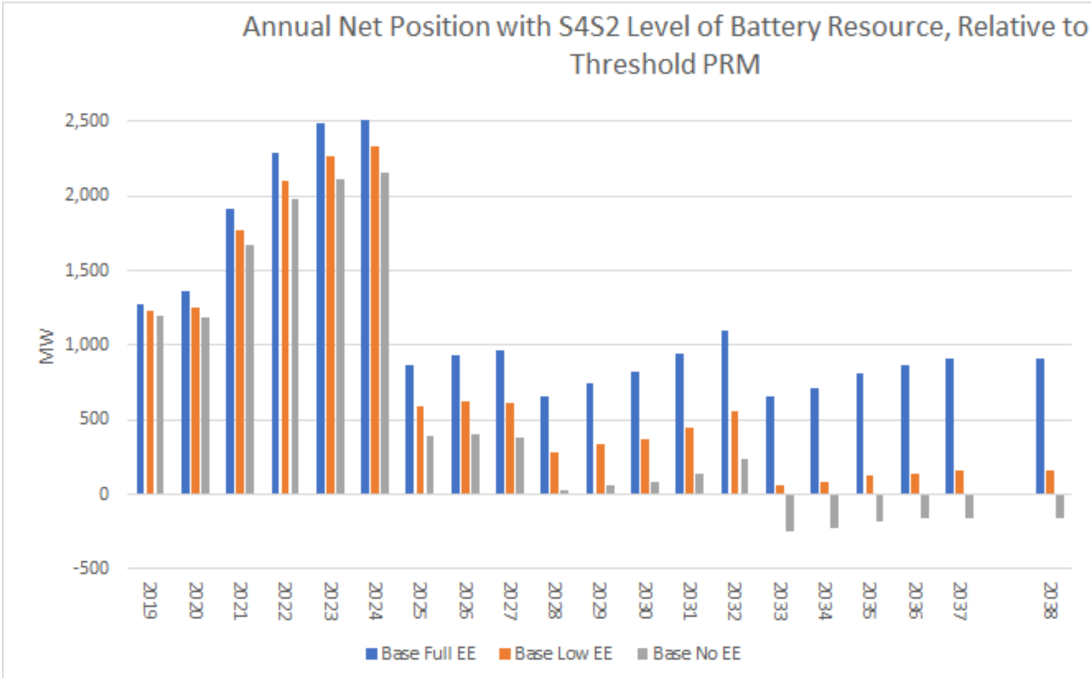
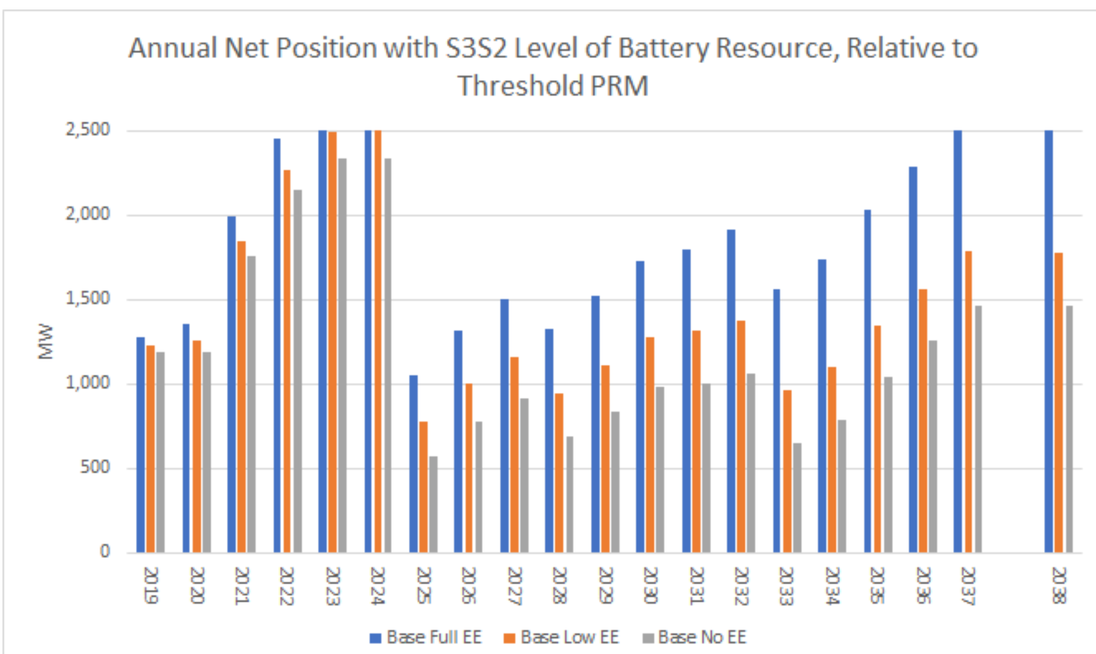
Figure 4. Annual Net Position with S4S2 Level of Battery Additions



Source: Source: PREPA existing capacity resource detail from "metrics detail" tabs of metrics file for Scenario S4S2; PREPA load forecasts reflecting base (Full EE), Low EE, and No EE and 30% PRM. Tabulation and graphic production by Synapse.

Figure 5. Annual Net Position with S3S2 Level of Battery Additions



Source: PREPA existing capacity resource detail from "metrics detail" tabs of metrics file for Scenario S3S2; PREPA load forecasts reflecting base (full EE), Low EE, and No EE and 30% PRM. Tabulation and graphic production by Synapse.

351. Figure 4 and Figure 5 above illustrate that batteries alone, without new fossil-fired capacity, could allow minimum PRM capacity needs to be met as MATS-impacted units retire, and assuming Costa Sur 5&6 remain in service (with any retirement or closure of return to service of either or both Costa Sur units, for the year or years in which they might retire, the "headroom" above minimum requirements is decreased). Higher levels of EE, as seen in the "Base Full EE" columns above, allow for the minimum reserve margin to be met with lower levels of battery installation because the peak load in Base Full EE scenarios is lower than in the other Base Low EE and Base No EE scenarios. Figure 5 also illustrates the importance of higher levels of peak load reduction from EE, and the presence of more battery capacity, in the later years when capacity from AES and EcoEléctrica may not be available. Figure 4 and Figure 5 show that with No EE or Low EE, 2025 and 2026 are critical years in the early portion of the planning period, when PRMs are at their lowest.

352. The PRM is high when counting all of the existing capacity but is much lower when both Costa Sur 5&6 and MATS-affected resources are unavailable, and when capacity is lost with AES and EcoEléctrica contract cessation, as seen in Figure 4 and Figure 5 above. This outcome indicates that increasing headroom (beyond minimum requirements) for economic retirement of MATS-impacted units will occur only after capacity installations.[355] Capacity installations are represented by the battery resources chosen in S4S2 and S3S2 and seen in Figure 4 and Figure 5.

353. This analysis further indicates that new gas-fired peaker replacements are not necessarily required for PRM purposes. This outcome assumes that: if it is assumed that battery resources of a similar scale as required in PREPA's scenarios will be installed – first - in accordance with the early-year timelines in those scenarios; and that the capacity at Costa Sur 5&6 remains at least until such battery resource installations allow PREPA's annual net position to be higher than the Costa Sur units' output, which is seen in Figure 5 as occurring as early as 2025, provided that peak reductions from "full" EE resources are captured. The exception to this finding, that gas-fired resources are not needed, exists only if one abides by PREPA's definition of capacity need under the proposed MiniGrid construct. That construct imposes effectively higher PRMs on the system and directly states that "thermal" or fossil-fired resources are required.[356]

354. The MiniGrid construct as envisioned, or designed, by PREPA requires a large amount of thermal resources for "critical load" (as defined by PREPA, which includes *all* load on *all* feeders with *any* critical load), a crucial assumption that has not been demonstrated

[355] *See* Proposed IRP, Caveat number 17, page 9-4. PREPA notes the importance of load reductions through EE, new generation resources, and reliability of the remaining fleet when considering the exact times for retirement of these units.

[356] *See* Proposed IRP, Appendix 1, Section 2, page 2-6.

by PREPA to be the optimal approach.[357] It may be reasonable to consider some limited thermal peaker replacement, but even that is questionable as an optimal solution, given the surplus capacity indications seen above that will arise as "no regrets" battery installations are completed in Puerto Rico.[358]

355. Also, as is addressed in Part III(I) of this Final Resolution and Order, with selective hardening of critical transmission circuits between regions (separate from MiniGrid investments)[359] and more optimal transmission/distribution reinforcement generally,[360] the local resource needs could be met at least in part by resources from adjacent mini-grid regions, in addition to battery installations installed locally. PREPA did not analyze in appropriate depth this seemingly realistic scenario.[361] Its analyses in this regard were limited only to the VOLL computations[362] used to indicate that the cost of capacity requirements PREPA imposed were exceeded by the benefits claimed for reducing such outages. However, PREPA did not demonstrate that its approach was the least cost or optimal way of achieving such outage-reduction benefits, as it did not test the cost of competing resiliency options.[363]

356. This Chapter 5 as filed by PREPA, and including its ROI response with PRM for each Scenario,[364] does not specifically detail either of the requirements of Regulation 9021 (*i.e.*, PRM under existing resources and load and resource balance under existing resources)[365] even though IRP-filed data readily allow those metrics to be produced.

357. Instead, this chapter of PREPA's filing describes an approach to meet other criteria that have not yet been demonstrated to be economically optimal – namely, an 80% local resource requirement under its defined Strategy 2 and thermal capacity requirements to meet critical load under the MiniGrid approach. There is no allowance for relaxing

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357 PREPA response to Energy Bureau's ROI 1-3 (f).

358 Dr. Bacalao indicated that battery resource installation is part of a "no regrets" solution for PREPA. Evidentiary Hearing, February 7, morning session, 01:32:00 to 01:34:00.

359 PREPA Confidential Attachment 1 to the response to ROI-1-6, describing hardening of transmission infrastructure separate from MiniGrid investments.

360 *See* Proposed IRP, Appendix 1, pages 2-98 to 2-104.

361PREPA did not modify any capacity resource requirement within a MiniGrid region to account for situations where the interconnections between MiniGrid regions might remain intact. Essentially, since no sensitivity was performed to consider a smaller number of MiniGrids, the amount of local generation reserve requirement was never optimized. *See* PREPA response to Energy Bureau's ROI 1-3 d) and f).

362 *See* Proposed IRP, Appendix 1, Section 2.15, pages 2-104 to 2-107.

363 *See* Part III(I)(24)(c) of this Final Resolution and Order for further discussion on the extent to which the MiniGgrid construct was not "fully optimized" as stated by Dr. Bacalao. Evidentiary Hearing, February 65, morning session, circa 01:08.

364 PREPA's Response to ROI 1-7, Attachment 1.

365 *See* Regulation 9021, § 2.03(E)(1) and (2).

these local resource constraints even when pursuing local resilience approaches that may include the value of interconnecting transmission lines between regions, and using non-thermal resource capacity to provide some portion of restoration services for critical loads.

358. The effect of PREPA's limited Resource Need Assessment is a result of two PREPA assumptions: first, stating that the resource plan needs to include new gas-fired peaking resources; and second, relatively high overall PRMs result because PREPA has defined the MiniGrid zones to be so numerous (*i.e.,* eight) that a high overall resource requirement (*i.e.*, far in excess of 30% PRM) flows from the MiniGrid/Strategy 2 construct. Simultaneously, PREPA is planning for an extensive reinforcement of the grid that might otherwise minimize, or even obviate, the need for the full amount of local capacity resources that PREPA presumes is required in its somewhat arbitrary specification of a value of 80% for its local capacity resource requirement.

359. The Energy Bureau **DETERMINES** that PREPA's resource need analysis has not sufficiently conveyed fundamental information concerning the amount of capacity that PREPA may need over the planning horizon. The Energy Bureau also **DETERMINES** that underlying resource need can change depending on the decisions made to address optimal means to meet resiliency requirements. Part III(D) of this Final Resolution and Order will address those requirements in more detail.

E. New Resource Options – DG and Utility-Scale Supply Resources

360. Sections 2.03(F)(1), (2), and (3) of Regulation 9021 require PREPA to describe new resource options that may be used to meet PREPA customers' needs. Those options include utility-scale supply resources and DG options. It also states that the Proposed IRP shall identify new storage resource options and include a valuation framework for those options.

361. Section 1.9 of Act 17 also requires similar content in the IRP – this part of the Final Resolution and Order addresses Section 1.9(3)(C) ("An evaluation of the range of conventional and non-conventional generation technologies available in the market."), Section 1.9(3)(J) ("Projections with regards to the integration of DG into the electric power grid."), and some aspects of Section 1.9(3)(E) ("A comparative evaluation of the energy supply resources, including transmission and distribution.").

1. PREPA Filing

362. PREPA's IRP considers a number of generation options as new supply resources. It regards potential actions by customers with respect to DG as fixed inputs, and primarily focuses on options for utility-scale resources. PREPA determined pricing and performance of different options based on a combination of literature review and expertise from Siemens, PREPA's consultant. For each one of the potential resources,

PREPA determined cost, performance, and availability. Resources that require extended lead time prior to operation were accorded that lead time. As discussed in detail below, PREPA also limited the availability of some resources based on judgements regarding the pace at which resources could be developed and interconnected.

363. In keeping with Puerto Rico's current policy, PREPA assumed that new resources would be under contract to PREPA through a PPOA structure, rather than utility-owned or developed.[366] Throughout this section, PREPA assumed that resource developers would be able to acquire financing with PREPA as a counterparty. PREPA assumed a weighted average cost of capital for new developments of 8.5%.[367] This corresponds to a 3.4% cost of debt (after tax) and 12.91 percent cost of equity, with a capital structure of 53 percent equity and 47 percent debt.[368] PREPA calculated capital cost recovery factors for each type of generation, reflecting the lifetime of each asset.[369] PREPA assumed that all fossil fuel assets would be entirely recovered (fully depreciated) by 2050, in keeping with Act 17, so the asset could be fully retired without stranded costs.[370]

a. Fossil fuel fired resources

364. PREPA characterized a range of traditional fossil-fuel-fired generation options, including combined-cycle, simple-cycle GTs, and reciprocating engines. PREPA identified classes of generators in which multiple products exist to supply similar amounts of capacity with similar performance characteristics, and then selected example products in each class from a variety of manufacturers based on their performance in Puerto Rico conditions.[371] PREPA used industry-standard GT Pro software to model the performance of these units and set the relevant parameters of these units for use in the AURORA capacity expansion model (discussed in Part III(G)).[372] For reciprocating internal combustion engines (RICE units), Siemens used published performance information for a large engine capable of dual fuel.[373] PREPA analyzed all generators in configurations that can run on either natural gas or diesel. PREPA assumed natural gas would be the primary fuel when available.[374]

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[366] *See* Proposed IRP, page 6-2.

[367] *See* Proposed IRP, Exhibit 6-1, page 6-2.

[368] *Id.*

[369] *See* Proposed IRP, Exhibit 6-12, page 6-3.

[370] *See* Proposed IRP, page 6-3.

[371] *See* Proposed IRP, page 6-3 and 6-4.

[372] *See* Proposed IRP, page 6-4.

[373] *Id.*

[374] *Id.*

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

365. To estimate the capital cost of each fossil fuel generating option, PREPA used the PEACE capital cost estimating software tool that is associated with the GT Pro software program.[375] The overall system capital cost in the PEACE software includes equipment and installation costs (including foundations, piping, wiring, etc.) as well as contractor engineering, commissioning overhead, escalation, contingency, and fees (to determine the engineering, procurement, and construction or "EPC" price). Owner's costs for development, permitting, and legal/contracting were also included. PEACE assumed development costs were equal to 9% of the EPC price.[376] PEACE software includes some location-specific cost adjustment for labor and materials costs but does not include adjustments specific to Puerto Rico. PREPA applied the U.S. Department of Defense Area Cost Factor for Puerto Rico (DoD Area Cost Factor), or 16 percent, to equipment, material, and labor costs to the PEACE outputs.[377] PREPA states that the cost estimates from PEACE are not as accurate as obtaining project-specific cost information from suppliers, but they do provide a consistent approach across all fossil fuel resource options.[378] The resulting capital costs are provided in Proposed IRP Exhibit 6-15. PREPA's workpaper "PREPA Fossil New Resources 10-9 2018_v6.2"[379] includes the PEACE results as well as the 2018 National Renewable Energy Lab (NREL) Annual Technology Baseline (ATB) values for gas combined cycle and combustion turbine plants. The cost results from PEACE, after the 16% DoD Area Cost Factor is applied, are approximately 15% lower than the 2018 ATB values from NREL (with variation depending on which specific plant type is compared to the NREL value).[380]

366. PREPA assumed that capital costs for the fossil fuel generation options would fall slowly in real (inflation-adjusted) terms over the course of the study period, based on the 2018 NREL ATB.[381] The Proposed IRP states that according to PREPA, the price estimates should be considered to be accurate to within -15% to +30%.[382]

367. PREPA calculated the levelized cost of energy (LCOE) for each new fossil fuel generation option, assuming the base case fuel prices and fuel infrastructure costs discussed in Part III(F).[383] The LCOE depends on the capacity factor of each facility, because the capital costs of the facility need to be recovered over more or fewer MWh of generation

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375 *See* Proposed IRP, page 6-11.

376 *Id.*

377 *Id.*

378 *Id.*

379 PREPA Workpaper, "PREPA Fossil New Resources 10-9 2018_v6.2."

380 *Id.* at Sheets "GTCC Cases (2018)," "Capital Cost Curve" and "NREL 2018 ATB."

381 *See* Proposed IRP, page 6-12.

382 *Id.* at page 6-13.

383 *Id.* at pages 6-14 to 6-15.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

if the capacity factor is higher or lower, respectively. For CCGTs, PREPA calculated example LCOEs for capacity factors between 5% and 90%, but features the range between 40% and 80% as the most likely range for operation.[384] For GTs and RICE units, PREPA features the capacity factor range between 5% and 30%.[385] The LCOEs by capacity factor and system type are presented in Chapter 6 of the Proposed IRP for informational purposes; the Aurora modeling software calculated the actual capital and operating costs each year for each facility as part of its long-term modeling.[386]

i. Combined cycle gas turbines

368. PREPA selected seven representative combined cycle units with different capacities and levels of performance as options for modeling, and characterized their expected cost and performance. These units were:

- H Class GE S107HA.01 (449 MW maximum capacity);
- F Class GE S107F.05 (369 MW maximum capacity);
- F Class GE S107F.04 (302 MW maximum capacity);
- Hitachi H-100 (144 MW maximum capacity);
- GE LM6000 DLE (66 MW maximum capacity);
- GE LM2500 + G4 SAC (38 MW maximum capacity); and
- GE LM2500 SAC (29 MW maximum capacity).

369. Exhibits 6-2 through 6-9 of the Proposed IRP provide the performance characteristics and operations and maintenance costs for each of these units as modeled, operating on both natural gas and diesel fuel. Each of these units is capable of cycling in and out of service daily, with short minimum run time and downtime. PREPA assumed that the required development timeline for CCGT options ranges between 4 years (for the small CCGTs) to 5.5 years (for the H Class CCGT), split roughly evenly between the development and EPC periods.[387]

370. In Exhibit 6-20 of the Proposed IRP, PREPA shows its estimated LCOEs for each of the new large CCGT options, alongside the equivalent curves for EcoEléctrica and Costa Sur (each under the relevant then-existing contract, as well as EcoEléctrica under an assumed reduced capacity payment), as well as the AES coal plant.

[384] *Id.* at pages 6-15 to 6-16.

[385] *Id.* at pages 6-17 to 6-19.

[386] *See*, e.g., the "Costs by Resource" sheet within any of the "Metrics" files provided in PREPA's workpapers.

[387] *See* Proposed IRP, page 6-14.

ii. Simple cycle gas turbines, combined heat and power, and reciprocating engines

371. PREPA selected three representative GTs with different capacities and levels of performance, as well as a small CHP plant and a RICE unit, as options for modeling, and characterized their expected cost and performance. These units were:

- GE LM6000 DLE (41 MW GT peaker);
- GE LM2500 SAC (22 MW GT peaker);
- FT8 MOBILEPAC 25 DLN (23 MW Mobile GT);
- Solar Turbines Mars 100 (9 MW CHP); and
- Wartsila 18V50DF (16 MW RICE).

372. Exhibits 6-10 through 6-13 of the Proposed IRP provide the performance characteristics and operations and maintenance costs for each of these units as modeled operating on both natural gas and diesel fuel, except for the CHP unit. The CHP unit is characterized in Appendix 4, in Exhibit 4-1. CHP units are modeled as "must-run," although they were assumed to meet only 30% of the host sites' peak load.[388] PREPA did not address how natural gas might be supplied to CHP units.

373. PREPA assumed that the FT8 MOBILEPAC 25 DLN mobile GTs installed at locations that currently host older GTs would be ten percent (10%) less expensive than at new sites.[389]

374. PREPA assumed that the required development timeline for all of these small generators is 3 years, split evenly between the development and EPC periods.[390] In Exhibit 6-22 of the Proposed IRP, PREPA shows its estimated LCOEs for each of the GT, small CCGT, and RICE options (except for the Mobile GT unit). PREPA shows that the 66 MW GE LM6000 DLE and 144 MW Hitachi H-100 are cost-competitive even at low capacity factors.[391] Exhibit 6-24 of the Proposed IRP includes the equivalent information for the CHP option.

b. Wind

375. Siemens developed overnight onshore wind costs from the 2018 NREL ATB.[392] PREPA modeled mid-case (base case) solar PV costs based on the NREL ATB Mid Case, and low-

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[388] *See* Proposed IRP, Appendix 4, page 4-2.

[389] *See* Proposed IRP, Exhibit 6-16, page 6-10.

[390] *See* Proposed IRP, page 6-14.

[391] *See* Proposed IRP, Exhibit 6-22, page 6-17, and discussion on page 6-16.

[392] *See* Proposed IRP, page 6-32.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

case costs based on the NREL ATB Low Case.[393] PREPA states that the Proposed IRP analysis includes the effect of the Federal investment tax credit for wind generation, which was set to expire at the end of 2019 as of the time when the Proposed IRP was developed (it has subsequently been extended to the end of 2020).[394] The Proposed IRP does not address the production tax credit.

376. PREPA assumed that wind projects in Puerto Rico would use the TRG-8[395] wind resource and technology development pathways, which matches the wind conditions in Puerto Rico.[396] TRG-8 includes increasing capacity factors over time, which results in decreases in the LCOE of wind over the study period.[397] PREPA calculates levelized cost of new wind resources in the mid case that fall from $121/MWh in 2021 to $99/MWh in 2038.[398] In the low-cost case (which also has higher capacity factors), the highest LCOE is $106/MWh in 2021 and the lowest is $53/MWh in 2038.[399]

377. PREPA developed hourly wind generation profiles from meteorological data and a functional form that maps wind speed to turbine generation (corresponding to a generic wind turbine). AWS Truepower developed the meteorological data as part of the PREPA Renewable Study.[400] PREPA developed these resource shapes from AWS Truepower profiles for five locations around the island (AWS sites 07, 10, 15, 17, and 22, which are shown in Exhibit 6-46).[401] PREPA scaled the total output to match the assumed capacity factor from the NREL ATB for a generator deployed in a given year.[402] For the purposes of the hourly output profile, PREPA assumed three tiers of capacity factor based on the NREL data: twenty-eight percent (28%) for 2020-22, thirty percent (30%) for 2023-29, and thirty-three percent (33%) for 2029-38 in the base case, and thirty-one percent (31%), thirty-four percent (34%), and thirty-nine percent (39%), respectively, in the low case.[403]

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[393] *See* Proposed IRP, Exhibit 6-41, page 6-33.

[394] *See* Proposed IRP, page 6-33.

[395] TRG stands for "techno-resource group".

[396] *See* Proposed IRP, page 6-33.

[397] *See* Proposed IRP, page 6-34.

[398] *See* Proposed IRP, Exhibit 6-42, page 6-34.

[399] *Id.*

[400] *See* Proposed IRP, page 6-38, and Siemens, 2014. *PREPA Renewable Generation Integration Study*. Accessed at https://aeepr.com/es-pr/Documents/Siemens%20PTI%20Final%20Report%20-%20PREPA%20Renewable%20-%20final-11.pdf.

[401] *See* Proposed IRP, page 6-41.

[402] *See* Proposed IRP, pages 6-38 and 6-39.

[403] *See* Proposed IRP, page 6-40.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

378. PREPA excluded offshore wind from being offered to the model. Section 6.8 of the Proposed IRP provides PREPA's justification.[404] PREPA grounded its decision to exclude offshore wind on the following points:

- PREPA expects offshore wind to have higher costs than equivalent solar PV, informed by a 2015 study;
- Puerto Rico is not expected to have an offshore wind resource comparable to that in locations where offshore wind is being actively developed, such as the Northeast U.S. and Europe;
- Further analysis would be expensive and time consuming for inclusion in this IRP; and
- Solar PV could be displaced by offshore wind if offshore wind showed lower costs.

c. Utility-scale solar PV

379. PREPA developed overnight solar PV costs from the 2018 NREL ATB.[405] PREPA modeled mid-case (base case) solar PV costs based on the NREL ATB Mid Case, and low-case costs based on the NREL ATB Low Case.[406] PREPA modeled the cost of one-axis tracking PV systems, although it used the capacity factor of fixed systems.[407] PREPA assumes the cost premium for one-axis tracking is comparable to the cost of hardening solar arrays against hurricanes.[408] PREPA developed installed capital costs and LCOEs for solar PV by accounting for:

- Puerto Rico-specific, and higher than NREL, interconnection costs in Puerto Rico;[409]
- Puerto Rico-specific, and higher than NREL, land costs in Puerto Rico;[410]
- The phase-out of the federal Investment Tax Credit (ITC);[411]
- A 1.3 DC-to-AC ratio;[412]

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[404] *See* Proposed IRP, page 6-42.

[405] *See* Proposed IRP, page 6-19.

[406] *See* Proposed IRP, Exhibit 6-25, page 6-20.

[407] *See* Proposed IRP, page 6-19.

[408] *Id.*

[409] *See* Proposed IRP, page 6-20.

[410] *Id.* at page 6-21.

[411] *Id.*

[412] *See* Proposed IRP, Exhibit 6-32, page 6-23.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

- A twenty-two percent (22%) AC capacity factor;[413] and,
- A sixteen percent (16%) "Puerto Rico Adder," based on an Army Corps of Engineers assessment of the relative costs of construction in Puerto Rico.[414]

380. PREPA assumed a 30-year lifetime for solar PV generators[415] and the same 8.5 percent WACC as for all new supply options.[416] Using these parameters, PREPA developed low-case and mid-case levelized costs of energy from solar PV installed in each year. The results are shown in Exhibit 6-33 of the IRP. The mid-case LCOEs in 2018 dollars range from $63/MWh (2020) to $78/MWh (2023) during the study period, rising in the near term as the ITC ramps down, and then falling slowly (in real terms) into the future. The ratio between the low- and mid-case solar costs ranges between 1.12 in 2021 to 1.49 at the end of the study period. In the modeled scenarios, most PV is installed near the beginning of the study period (2024 or earlier), when the ratios range between 1.12 and 1.18.[417]

381. PREPA assumed that the pace at which utility-scale solar PV could be interconnected to the grid would be limited in each year. In Scenarios 1, 4, and 5, and in the ESM case, PREPA limited installation to 360 MW per year in 2020 and 600 MW per year for the rest of the study period.[418] For Scenario 3 and Sensitivity 1, which model lower cost and higher availability of solar and storage, PREPA raised the annual limit to 1200 MW in 2021 and all later years.[419]

382. PREPA modeled solar PV and storage as separate installations for the purposes of the IRP, but also assumed that actual RFPs for solar PV would include the battery storage necessary for integration of the PV.[420] The addition of battery storage to PV allows the storage to qualify for the ITC,[421] and also for PREPA to assume that all solar PV would not require additional hardware or cost to comply with PREPA's "minimum technical requirements" (MTRs) for interconnection.[422] PREPA developed hourly solar PV

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413 *Id.*

414 *See* Proposed IRP, page 6-23.

415 *See* Proposed IRP, Exhibit 6-32, page 6-23.

416 *See* Proposed IRP, page 6-21.

417 *See* Proposed IRP, Exhibit 6-31, page 6-23.

418 PREPA Responses to the Energy Bureau's ROI-9-01, December 6, 2019. Note that these values differ from those shown in the Proposed IRP, Exhibit 6-28 on page 6-22.

419 *See* Proposed IRP, Exhibit 6-29, page 6-22.

420 *See* Proposed IRP, page 6-27.

421 PREPA Responses to the Energy Bureau's ROI-9-03(a), November 27, 2019 (Workpaper, "PREB-PREPA ROI_9_03 Attach 1.xlsx", sheet "Resource Year" shows that PREPA has assumed that storage qualifies for the ITC).

422 *See* Proposed IRP, page 6-27.

generation profiles from meteorological data using the PVSyst software program. AWS Truepower developed the meteorological data as part of the PREPA Renewable Generation Integration Study.[423] PREPA developed these resource shapes from AWS Truepower profiles for locations around the island, which are shown in Exhibit 6-46. The PVSyst program calculates production for a specified solar PV plant given the solar irradiance data.[424] PREPA modeled a generic solar PV plant at each site, and then scaled the total output to match the assumed twenty-two percent (22%) capacity factor.[425]

383. PREPA did not consider distributed solar as a utility-selected resource. The potential interplay of utility and distributed PV is discussed below.

d. Storage

384. PREPA modeled lithium-ion batteries as the only option for BESS; these are the mainstream, large-volume batteries in production for grid use today.[426] PREPA used Siemens's battery cost forecast. Siemens developed battery price and performance data based on several sources, including the New York State Energy Research and Development Authority (NYSERDA), IHS Markit, Lazard, and NREL.[427] Each of these sources projects falling battery costs in real terms, with the rate of decrease faster in the near term and leveling out over time. The Siemens base case forecast is closest to the IHS Markit and Lazard projections. Siemens also developed a low battery cost case, used in Scenario 3.

385. PREPA assumed a 20-year asset life for battery systems.[428] PREPA did not include a price adder for deployment in Puerto Rico.[429] PREPA included 2-hour, 4-hour, and 6-hour battery systems in its modeling, in units of 40 MW.[430] PREPA included fixed and variable operating cost, as well as upfront capital costs; the values are shown in Exhibits 6-39 and 6-40 of the IRP.

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423 *See* Proposed IRP, page 6-38, citing to Siemens, 2014. *PREPA Renewable Generation Integration Study*. Accessed at https://aeepr.com/es-pr/Documents/Siemens%20PTI%20Final%20Report%20-%20PREPA%20Renewable%20-%20final-11.pdf.

424 *See* Proposed IRP, page 6-38.

425 *See* Proposed IRP, pages 6-38 and 6-39.

426 *See* Proposed IRP, page 6-28.

427 *See* Proposed IRP, page 6-30.

428 *See* Proposed IRP, Exhibit 6-32, page 6-23.

429 The "Resource Year" sheet within any of PREPA's Metrics workpaper files (such as "S3S2B_Metrics_Base_Case_SII.xlsx") includes the capital cost of the battery systems; these costs agree with the storage costs presented in the workpaper "PREPA IRP Solar Wind Storage Costs-Updated CF-Wind-final.xlsm", which in turn use the NREL ATB without any regional cost adjustment.

430 *See* Proposed IRP, page 6-31, as well as the "Resource Year" sheet within any of PREPA's Metrics workpaper files (such as "S3S2B_Metrics_Base_Case_SII.xlsx").

386. PREPA assumed that the pace at which BESS could be interconnected to the grid would be limited in each year. In Scenarios 1, 4, and 5, and the ESM case, PREPA limited installation to 40 MW in 2019, 200 MW per year in 2020, and 600 MW per year for the rest of the study period.[431] For Scenario 3 and Sensitivity 1, which model lower cost and higher availability of solar and storage, PREPA raised the annual limit to 1200 MW in 2021 and all later years.[432]

387. PREPA did not address distributed battery storage as a resource in the Proposed IRP, in either the new resource options or the customer/demand-side assessment presented in Appendix 4. PREPA's discussion of microgrids in the context of MiniGrids implies the use of distributed batteries, where the microgrid batteries could be among the BESS capacity installed to serve the balance load (that is, the non-critical load) within each MiniGrid area.[433] The batteries incorporated in the microgrids are not separated or identified as resources. PREPA did assume a sixteen percent (16%) Puerto Rico adder in the cost of distributed storage when conducting analysis of its future rates against self-supply options.[434]

e. Combined heat and power (CHP)

388. PREPA developed model parameters for two types of CHP systems, presented in Appendix 4 to the Proposed IRP. Each is a 9 MW unit, with an effective electric efficiency of forty-seven percent (47%), and thermal-included efficiency of up to seventy percent (70%). The two types differ in whether they burn natural gas or diesel fuel.

f. Distributed generation forecast

389. PREPA developed a single solar DG forecast based on the Annual Energy Outlook (AEO) from the U.S. Energy Information Administration (EIA).[435] PREPA scaled the current level of deployed DG by the national rate of increase shown in the AEO for Residential Sector Equipment Stock and Efficiency, and Distributed Generation-Solar Photovoltaic Capacity.[436] PREPA calibrated a forecasting model based on comparing its historical pace of DG deployment to the AEO. The model was used to create a forecast for distribution level DG generation over the IRP planning horizon.[437]

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[431] PREPA Response to Energy Bureau ROI-9-01, December 6, 2019, page 9. Note that these values differ from those shown in IRP, Exhibit 6-28, page 6-22.

[432] *See* Proposed IRP, Exhibit 6-29, page 6-22.

[433] *See* Proposed IRP, Appendix 1, page 2-12.

[434] PREPA Workpaper, "ESM_Rate_Impact_v3".

[435] *See* Proposed IRP, Appendix 4, page 3-19.

[436] *Id.*

[437] PREPA's Responses to the Energy Bureau's ROI-01-18(c), August 2, 2019.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

390. PREPA developed a base forecast for CHP DG by assuming that all proposed CHP projects that PREPA was aware of proceed over the course of the next several years.[438] In addition to this projected CHP, PREPA allowed the Aurora LTCE model to select CHP resources, resulting in additional CHP deployment beyond that which is included in the base forecast.[439]

391. PREPA projects new distribution and transmission-connected solar DG and CHP energy generation to increase from 128 GWh in 2019 to 2,416 GWh in 2038.[440] DG and CHP reduce the total demand for utility-supplied energy in 2038 by an additional fourteen percent (14%) beyond the base level of EE, relative to the gross energy demand.[441] When both the base level of EE and DG are included in the forecast, the resulting load to be met with utility-supplied resources shows a combined compound annual growth rate (CAGR) of -3.63% per year.[442]

392. Solar DG does not have a direct impact on peak demand, because Puerto Rico's peak occurs at night. In PREPA's model, consumer owned CHP has a net impact on peak demand of approximately 146 MW.[443] PREPA projects the peak demand to decline from 2,761 MW in 2019 to 1,706 MW in 2038 when the base level of EE and CHP are factored into the peak demand forecast.[444] This decline represents a CAGR of -2.56% as compared to a CAGR of -0.24% for the base gross peak demand forecast.[445] The combination of EE and customer-owned generation reduce the peak demand by thirty-six percent (36%) relative to the gross peak demand forecast by 2038.[446]

g. Distributed generation costs

393. PREPA treated distributed solar as a reduction in the load that the utility will be required to serve, but not in any other way as a utility resource. The amount of distributed PV does not vary by scenario and is not responsive to utility rates or other results of the IRP. Nonetheless, PREPA did develop and present analyses of the relative customer economics of utility rates, residential solar PV net metering, grid defection

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438 *Id.*

439 *See* Proposed IRP Appendix 4, page 4-1

440 *See* Proposed IRP, Exhibit 3-18, page 3-16.

441 *See* Proposed IRP, Exhibit 3-19, page 3-16.

442 *See* Proposed IRP, Exhibit 3-18, page 3-16.

443 *See* Proposed IRP, pages 3-22 to 3-23.

444 *See* Proposed IRP, Exhibit 3-26, page 3-23.

445 *See* Proposed IRP, Exhibits 3-24 (page 3-21) and 3-26 (page 3-23).

446 *See* Proposed IRP, Exhibit 3-27, page 3-24.

(full self-supply) with solar plus storage, combined heat and power, and use of a diesel generator.

394. PREPA presents an analysis of the relative costs for both the S4S2 and ESM cases. These comparisons can be found in Sections 8.2.13 and 8.3.10 of the filed IRP, respectively.[447] In each case, PREPA presents the generation component of rates as approximately eleven (11) to twelve (12) cents/kWh (rising as the study period continues), and the non-generation component relatively flat between 6.6 and 7.4 cents/kWh. The combined rate is approximately 19 cents in the near term, falling to near seventeen (17) cents, and then rising to 20 cents.[448] In each case, PREPA also presents a version with reduced non-technical losses (to 0.5%); the utility rates are lower in this version.[449] PREPA did not include any restructuring charge or debt repayment charge in its rate projection for this analysis. PREPA did model distributed solar PV customer economics with and without a separate non-bypassable charge.[450]

395. In order to make the customer-perspective comparison between PREPA service and the DG options, PREPA developed models for the cost of rooftop solar PV with and without the distributed storage required to supply reliable service to a non-grid-connected home. PREPA calculated the LCOE of solar net metering using the NREL ATB cost projections, adjusted by sixteen percent (16%) for increased installation costs in Puerto Rico, a 1.2 factor between the AC and DC capacity, and the solar ITC (calculated as though the project were eligible for the 10% commercial ITC after the higher ITC expires in 2022).[451] PREPA assumes a twenty percent (20%) capacity factor.[452] PREPA included the 1.2 AC to DC factor only in the first year (2019), which results in a twenty percent (20%) higher assumed cost in that year than in the subsequent years.[453] The LCOEs for years after 2019 range from $116/MWh in 2020 to $130/MWh once the ITC is reduced, and then fall, eventually reaching $86/MWh for systems installed in 2038.[454]

396. At these costs, PREPA's analyses show that the cost of energy from rooftop PV is greater than PREPA's cost of generation until 2028, but that rooftop PV using policies that allow customers to avoid the entire rate (including T&D costs), such as net metering, will be highly cost-effective. PREPA states that this confirms the assumption that solar PV with

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[447] PREPA Workpaper, "S4S2B_Rate_Impact_V3.xlsm" and "ESM_Rate_Impact_v3.xlsm" (calculations found within these workpapers).

[448] *See* Proposed IRP, Exhibits 8-37 (page 8-41) and 8-59 (page 8-60)

[449] *See* Proposed IRP, Exhibits 8-31 (page 8-41) and 8-60 (page 8-60)

[450] *See* Proposed IRP, Appendix 4, Exhibit 3-14, page 3-29.

[451] *Id.*

[452] *Id.*

[453] We believe this to be an inadvertent error, and address its impact in the discussion below.

[454] *See* Proposed IRP, Appendix 4, Exhibit 3-14, page 3-29.

net metering will continue to drive solar PV adoption similar to the adoption rates observed.[455]

397. PREPA calculated the cost of solar PV plus enough storage so that the combined resource can meet a household's total electricity needs (full self-supply). This requires a 6-hour battery with capacity of approximately half the solar PV capacity.[456] PREPA assumes that residential batteries cost twenty percent (20%) more than the equivalent utility-scale battery (on a per-kW basis), incur a sixteen percent (16%) cost increase factor for installation in Puerto Rico, and are eligible for the ITC.[457] This solar and storage self-supply configuration is close to the cost of PREPA's full rates, on an LCOE basis, and the cost of full residential self-supply falls below PREPA's rates in 2026 and remains below for the remainder of the study period.[458]

398. PREPA did not model a case in which an even greater acceleration of self-supply results in higher rates (due to even lower sales), nor did PREPA model a case with less use of customer-sited DG.

399. PREPA analyzed a commercial CHP option and a diesel generator option, in order to evaluate the customer economics for load defection by commercial or industrial loads. At an eighty percent (80%) capacity factor, CHP is generally cost-effective against the full rate, but more expensive than the generation portion alone.[459] As discussed above, PREPA assumed that CHP plants would only be able to offset a portion of the load at a given facility (thirty percent, or 30%, of peak load); this limits the potential market and the size of the aggregate CHP resource. PREPA allowed the Aurora model to determine the amount of CHP that was deployed, rather than setting a fixed amount as an input. PREPA assumes that diesel generators at an eighty percent (80%) capacity factor have an LCOE of $181/MWh, which is close to the all-in average rate, and substantially higher than the generation-only portion of the rate.[460]

400. PREPA's rebuttal testimony and briefs are discussed after the intervenor summaries.

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[455] *See* Proposed IRP, page 8-40.

[456] PREPA Workpapers, "S4S2B_Rate_Impact_V3.xlsm" and "ESM_Rate_Impact_v3.xlsm," "Residential" sheet.

[457] *See* Proposed IRP, Appendix 4, Exhibit 3-18, page 3-33.

[458] *See* Proposed IRP, Exhibits 8-37 (page 8-41) and 8-59 (page 8-60).

[459] *Id.*

[460] *Id.*

2. Intervenors

a. Environmental Defense Fund

401. In her Direct Testimony, Dr. Elizabeth Stanton testifies for EDF that Puerto Rico should learn from the example of Hawaii and develop low-cost renewable and storage resources.[461]

402. Dr. Stanton further states that offshore wind cost estimates produced by Lazard have declined 43 percent in the last five years, to $92/MWh in 2018.[462] Dr. Stanton does not provide estimates of the forward-going cost of offshore wind, nor does she offer offshore wind costs tailored to Puerto Rico's wind resource.

403. Dr. Stanton quotes the International Finance Corporation, which states that solar generators can often be built in 6 to 12 months, compared with 4-5 years for hydroelectric and fossil fuel generators.[463] Dr. Stanton points out that PREPA placed limits on the annual capacity of interconnection for solar and battery resources, but not for gas generators.[464] She points out that these limitations create a risk that the 2022 RPS requirements may not be met.[465]

404. Dr. Stanton argues[466] that the fossil fuel plants considered by PREPA in the Proposed IRP are at risk of becoming stranded assets if they are not full depreciated by 2050, when 100 percent of energy must be generated by renewables under Act 17. She claims that PREPA did not properly account for the shorter effective lifetime of fossil fuel assets that are installed closer to 2050 than their capital recovery period, and that the net present value of such scenarios should be increased. She recommends that costs be amortized over the viable lifetime, taking into account appropriate laws and regulations.[467] Dr. Stanton further states that PREPA does not account for the risk that reasonable interest rates may not be available for gas investments. Dr. Stanton states that investments in renewable generators are not at high risk to become stranded assets because their fuels are free.[468]

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461 EDF, Testimony of Dr. Elizabeth Stanton, October 23, 2019, page 4.

462 *Id.* October 23, 2019, at page 8.

463 *Id.* October 23, 2019, at page 18.

464 *Id.* at page 17-18.

465 *Id.* at page 19.

466 *Id.* October 23, 2019, at pages 19-24.

467 *Id.* at page 24.

468 *Id.*

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

405. In its Final Brief, EDF states that PREPA should encourage and facilitate prosumer solutions, including DG.[469] EDF states a concern that PREPA is underestimating the risk of customer defection to self-supply when considering its strategies.[470] EDF is further concerned that if households leave the grid, fewer customers will remain to share the burden of the utility's infrastructure costs.[471] EDF expresses concern that despite the growth in customer-sited solar and batteries, PREPA does not currently have any incentive or procurement process to engage customers or aggregate their resources into VPPs.[472] EDF recommends that PREPA investigate such programs and evaluate and encourage VPPs and behind-the-meter assets.[473]

406. EDF criticizes the Proposed IRP for placing limitations on the annual deployment of solar PV and battery storage, and states that PREPA's justifications for these limits are unsubstantiated.[474] EDF recommends that renewable energy and battery storage be placed on an equal footing with fossil fuel generation, with no arbitrary limits on their pace of deployment.[475] EDF further criticizes PREPA for considering solar and batteries as separate resources, rather than as a combined resource that could have reduced overall cost.[476]

407. EDF claims that the Proposed IRP under-estimated the benefits of wind power, and states that wind is "generally one of the lowest cost resources" and "one would have expected the IRP to include a significant amount of wind resources."[477] EDF claims that PREPA essentially only analyzed utility-scale solar PV and gas power plants, and did not analyze EE, DR, VPPs, or batteries combined with solar PV.[478]

408. EDF recommends that a technology-neutral RFP be issued (and facilitated by an independent third party) before the next IRP in order to solicit proposals for energy generation and storage options, and generate the prices used as inputs for IRP

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[469] EDF, Final Brief, March 6, 2020, page 2.

[470] *Id.* at page 24.

[471] *Id.* at page 25.

[472] *Id.* at page 49.

[473] *Id.* at page 50.

[474] *Id.* at page 20.

[475] *Id.* at page 44.

[476] *Id.* at page 21.

[477] *Id.* at page 27.

[478] *Id.* at page 32.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

modeling.[479] EDF further recommends that PREPA conduct a potential study for onshore and offshore wind, and use its results for the next IRP.[480]

409. In its Reply Brief, EDF recommends that PREPA and the Energy Bureau evaluate rooftop solar PV and utility-scale solar PV on a level playing field[481] and recognize that while utility-scale solar PV may have a lower LCOE, rooftop solar can also provide additional grid benefits (as well as customer-empowering approaches to clean energy and resilience) that should be considered alongside the LCOE.[482] EDF also provides steps that PREPA could take to include VPPs in the next IRP and future procurements. These recommendations include issuing an RFP for VPP bids to provide services, allowing VPPs to participate in service-specific RFPs for utility-scale resources, or offering a tariff for specific services.[483] In its Reply Brief, EDF reiterates its recommendation for a technology-neutral RFP and recommends that it be written broadly enough to allow VPPs to participate.[484] EDF also recommends that PREPA begin developing tariffs for services that VPPs could provide and consider simple programs like the Green Mountain Power "bring your own device" program.[485] EDF expresses support for the recommendations of Sunrun and the LEOs regarding processes to expedite integration of solar and storage.[486]

b. Local environmental organizations

410. Dr. Agustín Irizarry Rivera's written testimony, for the LEOs, includes a detailed calculation of alternative costs of rooftop solar PV and batteries. He derives a cost of 7.8 cents/kWh for rooftop solar PV generation in 2019, falling to 2.7 cents/kWh in 2030 and then to 1.8 cents/kWh in 2038.[487] He assumes that a customer owns the system and finances it using a personal loan; he does not assume use of the Federal Investment Tax Credit (ITC).[488] He references NREL's "U.S. Solar Photovoltaic System Cost Benchmark: Q1 2018" as the source of his cost estimates.[489] Dr. Irizarry Rivera cites an installed and financed cost of $\$2.37/W_{AC}$ for rooftop PV systems, based on the sum of the cost of the

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479 *Id.* at page 56.

480 *Id.* at page 52.

481 EDF, Reply Brief, April 20, 2020, page 7.

482 *Id.* at page 5.

483 *Id.* at page 13.

484 *Id.* at page 14.

485 *Id.* at pages 14-15.

486 *Id.* at page 20.

487 LEOs, Testimony of Agustín Irizarry Rivera, October 23, 2019, page 11.

488 *Id.* at page 18.

489 *Id.* at page 10; LEOs, Response to PREPA-LEO-1, November 24, 2019, page 2.

PV module, string inverter, balance of system structural and electrical, supply chain cost, tax, installation labor, permitting, and overhead, with a 1.15 DC to AC ratio and a personal loan at 4.5% interest for 60 months.[490] During the evidentiary hearing, the Energy Bureau's consultant asked Dr. Irizarry Rivera about the fact that the costs that he used from the NREL report did not include customer acquisition costs or profit. Dr. Irizarry Rivera testified that it is not necessary to include those costs because his analysis is conducted from the perspective of the customer who is acquiring what they need for their household, rather than from a developer's perspective.[491]

411. In his written testimony, Dr. Irizarry Rivera compares the cost of rooftop solar PV generation to the assumed cost of PREPA's renegotiated contracts with solar PV resources that have signed contracts with PREPA.[492] He states that PREPA should choose rooftop systems, even at PREPA's calculated cost of 15.3 cents/kWh, rather than the renegotiated systems at 15 cents/kWh, because the utility-scale projects will be subject to line losses, debt servicing costs, and administrative costs.[493]

412. Dr. Irizarry Rivera also criticizes PREPA for including, but not explaining, the sixteen percent (16%) cost adder for Puerto Rico-specific costs, and for using a 1.2 AC-DC conversion factor instead of a 1.15 ratio as suggested by NREL.[494] He also states that PREPA should have used the NREL ATB "R&D only" cost model, instead of the "R&D + Market" case because that latter case reflects market dynamics around the federal investment tax credit that would not apply to a residential homeowner using a personal loan in Puerto Rico.[495]

413. When examining the case of potential grid defection, Dr. Irizarry Rivera states that PREPA has overstated the required size of a battery for off-grid operation, because the daily average household consumption (13 kWh) is less than PREPA has assumed (17.8 kWh).[496] He further states that batteries in Puerto Rico cost less than PREPA has assumed. In a discovery response, he supplies the cost of a 3.6 kWh battery from a Puerto Rico supply warehouse as $2,395, or $665.30 per kWh.[497] Dr. Irizarry Rivera compares the cost of self-supply using his assumed costs to PREPA's current rates, and to PREPA's rates after application of the charge from the proposed restructuring

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[490] LEOs, Response to ROI PREPA-LEO-1, November 24, 2019, pages 2-3.

[491] Evidentiary Hearing, February 4, 2020, afternoon session simultaneous translation, 2:30-2:32 https://www.youtube.com/watch?v=VDtZ4xG48AU.

[492] LEOs, Testimony of Agustín Irizarry Rivera, October 23, 2019, page 12.

[493] *Id.*

[494] *Id.* at page 17.

[495] *Id.* at page 19.

[496] *Id.* at page 13.

[497] LEOs, Response to ROI PREPA-LEO-1, November 24, 2019, page 3.

agreement, and shows that the costs of self-supply are lower than the costs of grid-supplied power throughout the period, with the difference growing over time.[498] Dr. Irizarry Rivera concludes that PREPA customers are more likely to adopt self-supply and DG options than historical trends have indicated, driven by falling PV costs, restructuring charges, continued reliability challenges even during good weather, and the investment costs necessary to achieve reliable electric service.[499]

414. In the exhibit to his supplemental testimony, Mr. Sandoval for the LEOs presents a calculation that distributed storage could reduce peak loads by 10 to 16 MWs by 2025 and 25 to 37 MW by 2038, reflecting the effect of 6,000 distributed residential storage systems in the lower case and 9,000 in the higher case.[500]

415. In her Direct Testimony for the LEOs, Ms. Anna Sommer addresses the risk of customer exit from PREPA's system.[501] She shows that customer exit makes sense for customer economics in most years, particularly after the proposed Restructuring Support Agreement charges are included (Figure 3, page 11). She identifies that PREPA's rate may in fact be higher due to the way that capital investments are recovered in practice (with a declining amount each year as the asset depreciates), and the likelihood that additional grid hardening investments (such as MiniGrid investments) would create non-generation costs that are not reflected in the presented rates.

416. Ms. Sommer argues on pages 20-21 of her Prefiled Testimony that PREPA has overstated the capital cost of solar PV by adding an unnecessary conversion factor of 1.3 between DC and AC capacity as part of its calculation.[502] Ms. Sommer argues that the capacity factor is in units of kWh_{AC}/kWh_{DC} and therefore accounts for the conversion between DC capacity of solar panels and AC energy supplied to the electric grid.

417. Ms. Sommer also argues that PREPA has understated the cost of new combined cycle natural gas generators. She states that the costs that PREPA has assumed are lower (on a $ per kW basis) than the costs submitted in a recent RFP process in Indiana for larger facilities, which is counter to the expected economies of scale.[503] Ms. Sommer points out that the assumed sixteen percent (16%) adder for construction in Puerto Rico should,

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[498] LEOs, Testimony of Agustín Irizarry Rivera, October 23, 2019, pages 14-16

[499] *Id.* at page 20-21.

[500] LEOs, Supplemental Expert Testimony of Ronny O. Sandoval, December 11, 2019, Exhibit "A Distributed Energy Resource Roadmap for Puerto Rico: Phase 1 Report," pages 15-16.

[501] LEOs, Testimony of Anna Sommer, October 23, 2019, pages 9-12.

[502] *Id.* at pages 20-21.

[503] *Id.* at pages 21-22.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

on balance, make cost assumptions in Puerto Rico higher, rather than lower, than on the mainland.[504]

418. In their Final Brief, the LEOs argue that the cost of distributed solar is substantially lower than PREPA assumed in the IRP, and that PREPA should have acquired real-world costs from existing customer-sited generation or installers in Puerto Rico, rather than relying upon NREL sources.[505] The LEOs argue that PREPA has assumed that DG is two to four times as expensive as on the mainland, with the difference growing over time, and that this is not supported by real-world costs in Puerto Rico.[506] The LEOs argue, in particular, that the sixteen percent (16%) DoD Area Cost Factor is inconsistent with real-world costs, at least for rooftop solar.[507] The LEOs reiterate many of these points in their Reply Brief.[508]

419. The LEOs' Final Brief argues that DG could contribute "far more" to the grid than PREPA predicts in the Proposed IRP, if the cost of distributed systems is lower than PREPA's estimates and if PREPA offers "proper incentives and better integration."[509] The LEOs state that if DG contributes more, then "less of the burden for building new generation would fall on PREPA and ratepayers."[510]

420. The LEOs' Final Brief reiterates Ms. Sommers's argument (detailed above) that the use of both a DC to AC conversion factor and the capacity factor result in overestimates of the cost of utility-scale solar.

421. The LEOs' Reply Brief addresses questions raised during public hearings, as well as supporting or opposing various statements by other Parties in their Final Briefs. Regarding the Energy Bureau's request to provide comments on the use of rooftop solar systems in lieu of utility-scale developments, of relevance to this section of the Proposed IRP, the LEOs suggest that PREPA must provide an expedited timeline for automatic interconnection of distributed PV systems, as well as net metering for those systems, after inspection by an independent engineer.[511] The LEOs also suggest that PREPA must coordinate with owners of distributed PV and storage systems to gain

[504] *Id.* at pages 22-23.

[505] LEOs, Final Brief, March 6, 2020, pages 10-11.

[506] *Id.* at page 11.

[507] *Id.* at page 12.

[508] See, e.g., LEOs, Reply Brief, April 20, 2020, pages 12-13.

[509] LEOs, Final Brief, March 6, 2020, page 12.

[510] *Id.*

[511] LEOs, Reply Brief, April 20, 2020, page 3.

visibility, and that PREPA should compensate customers for services these resources could provide to the grid.[512]

422. The LEOs' Reply Brief also addresses the Energy Bureau's request to provide comments regarding VPPs (*i.e.*, aggregators). The LEOS state that it is a "no-regret decision to leverage these [customer-initiated and paid for] projects for the frequency response and other grid services they can provide."[513] The LEOs caution, however, that aggregation should not be the only way to engage distributed resources. The LEOs suggest a "deeper, more holistic, and more proactive program to bring the benefits of DG to income- limited Puerto Ricans is needed."[514] Regarding procurement of VPPs, the LEOs emphasize the importance of rigorous adherence to the procurement processes established by regulation,[515] and refer to processes that were discussed at the evidentiary hearing such as requests for proposals, the use of tariffs and rates, and the use of programs that encourage EE and DR.[516] The LEOs state that credit unions and cooperatives can be effective models for engagement in low-income communities.[517]

423. The LEOs' Reply Brief states that PREPA did not properly analyze wind resources, because it did not take into account their energy output patterns. The Reply Brief quotes Dr. Bacalao stating that this was "one of the aspects that I think our analysis may be short."[518]

c. Not-for-profit intervenors

424. In his direct testimony for the NFPs, Dr. Eric Woychik testifies that solar PV, wind, and battery costs have fallen substantially in the last decade.[519] He recommends that DERs, including solar and storage, but also EE and DR, can be "orchestrated" to maximize value.[520] He notes that resources that can ramp, and that they can be relied upon during times of high load, have particular value and should be favored.[521] Dr. Woychik further recommends that the Energy Bureau only approve 1,000 MW of central station generation that is lower in costs than combined solar and storage (battery) or wind and

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[512] *Id.* at page 4.

[513] *Id.* at page 8.

[514] *Id.* at page 9.

[515] *Id.* at pages 9-10

[516] *Id.* at page 10.

[517] *Id.* at pages 11-12.

[518] *Id.* at page 22, citing Negociado de Energía en vivo, Evidentiary Hearing / CEPR-AP-2018-0001, YouTube (Feb. 5, 2020), https://youtu.be/vIXWJt52Hfk?t=13073.

[519] NFPs, Testimony of Dr. Eric Woychik, October 22, 2019, pages 7-8.

[520] *Id.* at page 9.

[521] *Id.* at page 11.

storage (battery) costs of $0.025/kWh.[522] He expresses concern that, since these costs are available now in the continental U.S., central station generation will become uneconomic if it costs more than this level.[523]

425. In their Final Brief, the NFPs argue that the electricity sector is "moving toward individual PV installation with battery support," and that PREPA's IRP fails to reflect this fact to capture benefits for its customers.[524] The NFPs argue that the resiliency offered by rooftop solar and batteries drives a new market reality in the wake of Hurricane María.[525] The NFPs further argue that, because rooftop solar and batteries could avoid the need to construct LNG facilities and transmission lines, using these technologies "mitigates the risk that grid defection will create new stranded costs."[526] The NFPs argue that the IRP failed to take into account VPPs, and that PREPA agreed in the evidentiary hearing that VPPs can substitute for other power plants.[527]

426. The NFPs state that a "solar behind the meter tax" associated with the proposed RSA would hasten grid defection, worsen PREPA's cash flow, and render the Proposed IRP unviable.[528] They argue that expensive electric rates will encourage customers to go "off grid," reducing Puerto Rico's "ability to afford sensible energy solutions."[529] The NFPs support a "collaborative effort" between PREPA, the Energy Bureau, customers, and DER providers to reduce costs and minimize grid defection.[530]

d. Progression Energy

427. In his Direct Testimony, Mr. Kevin Bannister testifies, on behalf of Progression Energy, to the availability and potential economic attractiveness of offshore wind resources for Puerto Rico. Mr. Bannister presents evidence that offshore wind costs have fallen in other parts of the world in the recent past, and that projections compiled by the U.S. Department of Energy show that experts expect the prices to continue to fall.[531] Mr. Bannister points out that offshore wind resources are expected to have levelized costs in some locations in the range of $60-$70/MWh, once the industry captures economies

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522 *Id.* at page 14.

523 *Id.*

524 NFPs, Final Brief, March 6, 2020, page 8.

525 *Id.* at page 9.

526 *Id.* at page 10.

527 *Id.* at pages 10-11.

528 *Id.* at pages 12-13.

529 *Id.* at page 16.

530 *Id.*

531 Progression Energy, Testimony of Mr. Kevin Bannister, October 23, 2019, lines 92-108.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

of scale.[532] Mr. Bannister testifies that PREPA was incorrect to assume that offshore wind would have the same daily pattern of generation as onshore wind, based on data from the National Data Buoy Center.[533] He uses a scaling relation to estimate the wind speeds at the height of wind turbines (because the existing buoys are not as tall as a turbine), then maps this wind speed to the expected production from a Siemens wind turbine.[534] Mr. Bannister shows that, based on his analysis, offshore wind has a substantially different load shape from onshore wind and from solar PV, as show in his Figure 12.[535] Mr. Bannister concludes his testimony with recommendations for further analysis, and argues that the IRP should not be approved without properly evaluating all generating resources.[536] He states that Progression Energy's technology would allow development near the north shore of Puerto Rico, and recommends that up to 500 MW of offshore wind be included in the IRP.[537]

e. Solar and Energy Storage Association – Puerto Rico

428. In his Direct Testimony, Mr. Patrick J. Wilson recommends changes to some of the assumptions regarding the adoption of distributed solar PV and storage. He identifies a number of current and likely future developments which he believes the Proposed IRP has not accounted for, such as Community Development Block Grant Disaster Recovery funding for DG ($400 million), payments for RECs, cost reductions for innovation, aggregation of generation and storage, emerging financing options, the adoption of storage with solar as common practice after Hurricane María, and new companies offering solar and storage in new ways.[538] Mr. Wilson suggest that DG should be the subject of a more in-depth analysis than is presented in the Proposed IRP.[539]

429. During the evidentiary hearing, Mr. Wilson testified that it is very rare for customers installing solar and storage today to want to leave the grid.[540] He stated that because the monthly connection charge is only four dollars per month, even if the system were able to supply one hundred percent of a customer's consumption, using the grid as a backup is worth the small payment. Mr. Wilson testified that true net metering enables

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[532] *Id.* at lines 115-129.

[533] *Id.* at lines 185-219.

[534] *Id.* at lines 221-234.

[535] *Id.* at lines 247-253.

[536] *Id.* at lines 266-273.

[537] *Id.* at lines 274-277.

[538] SESA-PR, Testimony of Patrick J. Wilson, October 23, 2019, pages 15-16.

[539] *Id.* at pages 16.

[540] Evidentiary Hearing, February 4, 2020, 1:49-1:50.

customer certainty and market stability and is an enabler of the growth of solar.[541] He further stated that the proposed RSA would be a driver for grid defection.

430. SESA-PR's Reply Brief consists of identified sections of the briefs filed by other Intervenors with which SESA-PR agrees. Many of these relate to the topics in this part, and these items are discussed with the submitting party's materials.

f. Sunrun

431. In his Direct Testimony, Mr. Christopher Rauscher testifies in support of the use of aggregated solar and storage resources as VPPs. In such a configuration, distributed assets can be monitored and managed as a dispatchable resource at multiple levels of aggregation.[542] Mr. Rauscher states that VPPs can provide the same services as larger storage installations (such as peak and ramping services, spinning reserves, and frequency support)[543] while also providing unique capabilities depending on the location on the grid (such as localized transmission support, reducing strain on the distribution grid, voltage management, and small-area resiliency).[544]

432. Mr. Rauscher further testifies that he believes that distributed resources can be more cost-effective than central resources because they avoid line losses and can take advantage of customer contributions toward system costs.[545] The utility cost can be lower than bulk storage resources because the customer contributes to the cost to obtain their local reliability services.[546]

433. Mr. Rauscher notes that Dr. Bacalao stated at the Technical Conference that the VPP idea is "embedded" in the Proposed IRP.[547] Mr. Rauscher recommends that the VPP approach be made explicit.[548] Mr. Rauscher expresses a concern that if storage resources behind the meter are not explicitly accounted for and used as grid resources, PREPA will acquire bulk storage to provide that service, resulting in duplicative capital cost for Puerto Rico.[549] He states that a VPP approach is compatible with the Proposed IRP, which includes the development of substantial solar and storage resources within

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[541] *Id.* at 1:50-1:51.

[542] Sunrun, Testimony of Christopher Rauscher, October 23, 2019, page 4.

[543] *Id.*

[544] *Id.* at page 5.

[545] *Id.* at pages 5-6.

[546] *Id.* at page 7.

[547] *Id.* at pages 3-4.

[548] *Id.* at pages 8-9.

[549] *Id.* at page 9.

the next few years, and that VPPs can eliminate most interconnection and land costs while reducing the need for transmission capacity and spinning reserves.[550]

434. Mr. Rauscher calculates a potential scale for residential VPP solar and storage in Puerto Rico at 6.6 GW of solar and 12.4 GWh of storage.[551] He states that this scale indicates there is "no practical upper bound" if PREPA seeks to develop VPPs.[552] Mr. Rauscher describes the communication infrastructure required to aggregate and coordinate VPPs, and states that cellular chips or customer Wi-Fi networks can be used, so that no separate utility communications network is required.[553] He also states that aggregated batteries could also respond to price signals or schedules set by PREPA, without the need for integration into PREPA's control centers.[554] Mr. Rauscher describes the flexible options available for PREPA and aggregators to pay for services delivered without making changes to billing processes or rate structures; PREPA would pay the aggregator who could then offer various forms of compensation to participants.[555]

435. Mr. Rauscher suggests that VPP aggregations can be acquired cost-effectively by: defining the need, not the solution; sharing data; enabling creativity from providers; valuing modularity and flexibility; and evaluating options holistically.[556] Mr. Rauscher states that VPPs can support a MiniGrid approach, should PREPA and the Energy Bureau choose such an approach.[557] He suggests that public buildings (including schools, municipal buildings, and public housing) could be a good set of hosts for aggregated solar and storage resources while providing resiliency benefits.[558]

436. During the evidentiary hearing, the Energy Bureau's consultant asked Mr. Rauscher whether solar PV could be deployed at the scale envisioned in the Proposed IRP without customer acquisition costs or profits.[559] Mr. Rauscher testified that, for the case in which customers are procuring distributed solar PV systems independently, which is what the IRP assumes, customers acquisition costs and other soft costs are higher than the equipment costs. He further testified that the developer/installer must see a profit to be motivated to continue in business. Mr. Rauscher identified an alternate hypothetical case, in which – if PREPA was interested in hedging against grid defection – PREPA

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[550] *Id.* at page 11-12.

[551] *Id.* at page 14.

[552] *Id.*

[553] *Id.* at page 15.

[554] *Id.* at page 16.

[555] *Id.* at pages 16-17.

[556] *Id.* at pages 18-19.

[557] *Id.* at pages 19-20.

[558] *Id.* at pages 20-21.

[559] Evidentiary Hearing, February 4, 2020, afternoon session, 2:57-2:58.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

could develop a structure in which the utility is the off-taker of the power, and customers could be aggregated for batched installation.[560] In this case, he testified that the customer would receive some bill savings and reliable power while the developer receives a reasonable return, all while incurring lower customer acquisition costs.

437. At the evidentiary hearing, when asked about grid defection happening today, Mr. Rauscher testified that his firm sizes systems to keep customers on the grid, which he believes is more economic for the customer and the utility.[561] Later in the hearings, Mr. Rauscher testified that VPPs can be a hedge against grid defection because participants in VPPs can provide service to the utility and get paid for that service, while retaining resiliency for their homes.[562] Mr. Rauscher testified that nearly all solar in Puerto Rico is being installed with storage,[563] but that storage is not being used as a utility resource. In this way, he testified, "Puerto Rico probably has or will soon have the largest untapped VPP resource in the world."[564]

438. Sunrun's Final Brief states that both Mr. Rauscher's and other experts' testimony, including that of PREPA's witnesses, supports finding that VPPs can provide services indistinguishable from those provided by fossil fuel peaker generation; that VPPs are in "many ways" superior to other resource options (including utility-scale renewables); that VPPs are simple to procure using RFPs, tariffs, or programs; that VPPs are simple to build and grow given their modular nature; that VPPs can help defer spending on transmission infrastructure; and that solar and storage customers are untapped VPP resources being deployed each day.[565]

g. Wartsila

439. In his expert testimony, Mr. Brian Fladger of Wärtsilä North America (Wärtsilä) states that PREPA has assumed prices for RICE technologies that are incorrect.[566] He states that PREPA used a quote from Wärtsilä in 2015 to develop the cost used in the Proposed IRP, but that the current pricing from Wärtsilä is much lower than PREPA's assumptions.[567] Specifically, he states that Wärtsilä's current pricing for RICE engines ranges between $872 and $981/kW, while PREPA has assumed an installed cost of over

[560] *Id.* at 2:58-2:59

[561] *Id.* at 1:49.

[562] Evidentiary Hearing, February 7, 2020, morning session, 3:41-3:43.

[563] *Id*. at 3:40-3:41

[564] *Id.* at 3:42-3:43.

[565] Sunrun Final Brief, March 6, 2020, paragraph 1 (page 0) and paragraph 11 (pages 12-13).

[566] Wartsila, Testimony of Mr. Brian Fladger, page 6.

[567] *Id.*

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

$1,600.[568] Mr. Fladger states that PREPA should have contacted vendors to obtain the most accurate pricing information, rather than escalating a quote from 2015.[569]

440. Mr. Fladger also states that PREPA should have taken into account additional aspects of the performance of potential new generating units. In particular, he states that PREPA should have taken start-up costs into account when evaluating and modeling RICE and combined-cycle generators.[570] He states that combined-cycle plants that start up 300 times per year (approximately daily) would incur costs of approximately $5,000 to $10,000 per start, and would also incur higher O&M costs ($5/MWh instead of PREPA's assumed $1.75/MWh).[571] Mr. Fladger further states that PREPA's modeling should have differentiated between RICE and combined-cycle units with respect to the minimum downtime.[572]

441. In its Final Brief, Wärtsilä states that PREPA used inaccurate modeling inputs for RICE and CCGT units (as detailed in Mr. Fladger's testimony). Wärtsilä critiques Dr. Bacalao's rebuttal testimony regarding installation costs, and states that Wärtsilä is in a better position than PRPEA to know installation cost for its products.[573] Wärtsilä states that PREPA should have used the values that Mr. Fladger provided in his testimony.[574] Regarding start-up costs, Wärtsilä argues that by excluding these costs, which Dr. Bacalao stated should have been included, the Proposed IRP fails to reflect the true costs.[575] Similarly, Wärtsilä states that PREPA's modeling fails to differentiate between RICE and CCGT units on minimum downtime, which fails to reflect an advantage of RICE units.[576] Wärtsilä states that RICE units are more flexible than CCGTs, and are therefore better suited to renewable integration.[577]

h. Windmar

442. The expert written testimony of Mr. Víctor González's discusses the fact that the Proposed IRP does not address storage at levels other than the utility level.[578] He

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[568] *Id.* at pages 6-7.

[569] *Id.* at page 7.

[570] *Id.* at page 9.

[571] *Id.* at page 10.

[572] *Id.* at pages 10-11.

[573] Wartsila, Final Brief, March 6, 2020, pages 5-6.

[574] *Id.* at pages 5-6.

[575] *Id.* at page 7.

[576] *Id.* at pages 7-8.

[577] *Id.* at page 8.

[578] Windmar Group, Testimony of Mr. Víctor González, October 23, 2019, page 3.

recommends that storage be paid for ancillary services provided, and be simple to interconnect.[579] He suggests that on-site storage, with solar generation, is the ideal approach in his experience.[580]

443. During the evidentiary hearing, the Energy Bureau's consultant asked Mr. González whether solar PV could be deployed at the scale envisioned in the Proposed IRP without customer acquisition costs or profits.[581] Mr. González testified that customer acquisition costs are generally very high, but could be lowered to almost nothing if the deployment were done for a large number of households at once and in partnership with the utility. He further testified that as a businessman, maximizing profit is his objective. He stated that this profit compensates the developer for project development and performance risk.

444. At the Evidentiary Hearing, Mr. González also testified regarding whether the customers that his company serves with solar and storage are in a position to defect from the grid.[582] He testified that his firm encourages customers not to install enough storage to meet all of their demands, because most homes have an opportunity for EE gains. His firm does educate customers about identifying their critical loads so they can size the system to maintain resilient service to those loads. He further testified that he believes that if the RSA is approved with what he called a "solar tax," then customers will acquire additional panels and batteries to disconnect from the grid entirely.[583]

3. PREPA Rebuttal and Briefs

a. PREPA Rebuttal Testimony

445. Dr. Nelson Bacalao filed rebuttal testimony on December 20, 2019, that addressed many of the points raised by intervenor witnesses regarding the cost and/or performance of new generation options.

446. Regarding offshore and onshore wind, Dr. Bacalao presents the levelized cost of energy generated by onshore and offshore wind, using the 2019 NREL ATB that contains projected costs for offshore wind. Dr. Bacalao shows that, using PREPA's assumptions, both onshore and offshore wind are more expensive, on an LCOE basis, than solar PV in both the mid-case and low-case.[584]

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579 *Id.*

580 *Id.* at page 4.

581 Evidentiary Hearing, February 4, 2020, afternoon session, 2:55-2:57.

582 *Id.* at 1:47-48.

583 *Id.* at 1:49.

584 PREPA, Rebuttal Testimony of Dr. Nelson Bacalao, December 20, 2019, pages 2-3.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

447. Dr. Bacalao addresses the risk that the cost of generation would be higher because generation developers may not be able to access capital at reasonable interest rates. Dr. Bacalao argues that this risk applies equally to all generation or storage options, and that it is critically linked to the creditworthiness of the project offtaker (that is, PREPA).[585]

448. Dr. Bacalao addresses the assumption by the NFPs' witness Woychik that solar PV and storage can be obtained at a cost of $25/MWh. He states that the IRP was developed using NREL ATB costs, adjusted for Puerto Rico-specific factors (including import, land, and labor costs), and that $25/MWh costs are at "the very low range" of recent solar power purchase agreements in the United States. and in other countries.[586]

449. Dr. Bacalao addresses the concern raised by EDF's expert witness Dr. Stanton that the Proposed IRP understates the risk of gas plants becoming stranded assets because their lifetime extends past 2050, when all generation must be renewable. He explicitly states that all fossil fuel units are "fully amortized by 2050" and shows how the effective capital cost of generation options rises with their installation date.[587]

450. Dr. Bacalao addresses a number of concerns raised by Mr. Fladger for Wärtsilä about the modeling and assumptions regarding the cost and performance of RICE units and other fossil fuel generators. Dr. Bacalao states that the generator costs used in PREPA's analysis are intended to be reasonable and based on achievable costs, including any added costs to execute projects in Puerto Rico and owner's costs "such as development, project management, taxes, financing, project interconnection, etc."[588] Regarding assumed performance in the Aurora modeling, especially as it relates to up times and down times, Dr. Bacalao states that the Aurora model operates with a resolution of no less than one hour (and two hours in LTCE mode), so that performance on timescales shorter than this "would not make a difference in the selection of the technologies."[589] Dr. Bacalao acknowledges that the PREPA model did not consider startup costs, but argues that the added costs would be unlikely to change the equipment selection decision because the startups are driven by the need to minimize renewable curtailment.[590]

451. Dr. Bacalao responds to two arguments from Dr. Irizarry Rivera's testimony on behalf of LEO: i) that by Dr. Irizarry Rivera's calculations of rooftop solar is less expensive than the utility-scale solar that PREPA models, and ii) that PREPA should depend exclusively

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[585] *Id.* at page 4.

[586] *Id.* at page 5.

[587] *Id.* at pages 9-10.

[588] *Id.* at pages 11-12.

[589] *Id.* at page 11.

[590] *Id.*

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

on rooftop (rather than utility scale) solar PV. On the first point, Dr. Bacalao suggests that the difference in project financing (commercial, third-party financing versus a personal loan) may drive differences in resulting price.[591] He further points out that personal loans may not be available to all the households required to power the grid with rooftop solar PV,[592] and that Dr. Irizarry Rivera relies on mainland prices from NREL (rather than Puerto-Rico-specific prices), while PREPA adjusted mainland prices to account for Puerto Rico costs.[593] Dr. Bacalao further argues that "PREPA cannot prudently plan on the system relying on customer-owned generation that may or may not appear in the amounts required."[594]

452. On Dr. Irizarry Rivera's argument to depend on rooftop solar PV systems and not utility-scale, Dr. Bacalao argues that PREPA "…cannot simply hope that adequate amounts of rooftop solar photovoltaic capacity and energy storage capacity will materialize."[595] He further argues that in order to meet the aggregate need for energy, capacity and ancillary services, PREPA requires control over a set of resources, "…which it can dispatch as system needs and contingencies dictate. Utility-scale solar photovoltaic resources, coupled with battery energy storage systems, would qualify as such resources, as would gas-fired generating capacity."[596]

453. Dr. Bacalao responds to testimony from Mr. González, of Windmar, regarding distributed and utility-scale storage. Dr. Bacalao states that storage is a critical resource for the operation of the grid as renewable penetration increases, but that PREPA should not depend on distributed storage installed by customers because it could not guarantee that the necessary quantity and level of control would be provided.[597]

b. PREPA's Final and Reply Briefs

454. PREPA's Final Brief briefly summarizes the approach presented in the Proposed IRP itself regarding new generation options.

455. PREPA's Reply Brief responds to criticism regarding the imposition of modeling limits on the pace of solar PV and storage installation by arguing that other critical parties "have offered no evidence establishing that the limits are unreasonable, nor have they

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[591] *Id.* at page 16.

[592] *Id.* at page 17.

[593] *Id.* at pages 17-18.

[594] *Id.* at page 16.

[595] *Id.* at page 21.

[596] *Id.*

[597] *Id.* at page 22.

shown that PREPA is not ultimately constrained as to the rate at which renewable and storage resources can actually be added."[598] PREPA further states that:

> Given the constraints which PREPA, a potential T&D concessionaire and developers of solar PV and battery energy storage systems will inevitably face, as documented in the Proposed IRP Main Report at Part 6.4.6, it is simply not realistic, nor would it be responsible, for the Proposed IRP to assume that Puerto Rico could achieve a more rapid uptake of solar PV and battery energy storage systems ("BESS") than is reflected in the Action Plan. The evidence presented throughout these proceedings establish that the Action Plan, which reaches [forty percent (40%)] renewable penetration almost immediately, contemplates one of the most rapid rates of solar PV and battery energy storage development and capacity integration ever achieved anywhere in the world.[599]

456. PREPA adds that there will be limits to how much solar PV and BESS capacity can be added to the PREPA system each year is a matter of common sense. There are only so many interconnection projects PREPA can oversee and physically handle in a given period, and there are additional practical, safety and reliability concerns that constrain how much capacity can be added more or less concurrently to an operating transmission system.[600]

457. PREPA's Reply Brief addresses the relative contributions of distributed and utility-scale renewable generation, in response to critiques that the IRP does not place enough reliance upon distributed energy resources. PREPA states that the Proposed IRP assumes the availability of "substantial amounts of DG."[601] Furthermore, PREPA states that the Proposed IRP analysis:

> …shows that incentives for customers to develop customer-owned generation will continue through the planning period, and therefore projections of demand assumed that there would continue to be high levels of penetration of customer-owned generation, such as rooftop solar PV installations, and resources that could be aggregated through [VPPs]. Even so, the Proposed IRP's LTCE runs clearly show that the substantial amounts of distributed generation (including rooftop solar and other forms of customer-owned generation), energy efficiency and demand response anticipated over the planning horizon would not be

[598] PREPA, Reply Brief, April 20, 2020, page 17.

[599] *Id.* at pages 19-20.

[600] *Id.* at page 21.

[601] *Id.* at page 23.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

> sufficient to meet projected demand, and would need to be complemented by large amounts of utility scale renewable generation, as well as smaller but still substantial amounts of gas-fired generating capacity.[602]

458. PREPA reiterates Dr. Bacalao's statement during the Evidentiary Hearing that DG and storage resources could be aggregated to play a role of utility-scale resources.[603]

459. In its Reply Brief, PREPA responds to the LEO critique of the capital cost of gas power plants by describing the use of the PEACE cost estimating tool, which PREPA states is a broadly accepted tool and method for cost estimation.[604] PREPA emphasizes that the IRP analysis treated all generation resources consistently.[605]

460. PREPA's Reply Brief also addresses particular calculations made by expert witnesses for intervenors regarding the cost of solar PV. In particular, it addresses Ms. Anna Sommer's testimony (summarized below) by clarifying that the capacity factor used for calculating the levelized cost (and production) of solar PV is entirely an AC capacity factor (without the conversion between DC and AC included).

461. PREPA addresses other Parties' concerns regarding the calculation of the cost of DG. PREPA states that rooftop solar prices should not be the basis on which it develops it resource plan.[606] PREPA reiterates Dr. Bacalao's argument that PREPA "cannot prudently make resource planning decisions on the hope that thousands and thousands of rooftop solar plus storage installations will be procured, financed, installed and maintained over the next few years so that they can provide the large amounts of capacity and energy Puerto Rico will require from solar PV resources."[607] PREPA further argues that the costs of DG do not directly affect the quantity of distributed resources that is modeled in the IRP, that the IRP assumes that customers will continue to have a strong incentive to install solar PV, resulting in a need for utility-side resources that is "substantially lower than it would be otherwise,"[608] and that even if distributed resources cost less than the IRP assumes, the conclusions of the IRP would be unaffected.[609]

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[602] *Id.* at page 24.

[603] *Id.*

[604] *Id.* at pages 25-26.

[605] *Id.* at page 26.

[606] *Id.* at page 44.

[607] *Id.*

[608] *Id.* at page 45.

[609] *Id.*

462. Regarding the use of an RFP to determine the costs of resources before a Proposed IRP, PREPA argues that it is appropriate to use "planning-level cost estimates based on industry standard sources of information,"[610] rather than "putting the cart before the horse by having PREPA run multiple RFPs for generation resources before it has the benefit of the Proposed IRP analysis to shape these RFPs."[611]

4. Discussion

a. Use of the DoD area cost adder

463. PREPA used a sixteen percent (16%) capital cost factor to increase the cost of nearly all technologies considered in the IRP.[612] The cost factor is based on U.S. Department of Defense Area Cost Factors.[613] The Department of Defense uses cost factors like this to estimate how costs for military facility construction will vary between different locations within the United States and around the world.[614] PREPA uses this factor to reflect its belief that development and deployment of energy generation technologies is more expensive in Puerto Rico than on the U.S. mainland,[615] in the absence of actual costs or offered prices for new generation technologies for installation in Puerto Rico.

464. Energy generation technologies are not typical construction. Local materials form a relatively small portion of the materials (and even more so, the value of the materials) used to construct a generator. Much of the cost is for equipment that is constructed in factories elsewhere (such as GTs or solar panels), and then moved to the site. The fraction of costs for labor (relative to materials) can also be quite different from typical construction. These factors make us skeptical about the use of a cost adder developed for use in typical construction.

465. However, we do understand that there are additional costs for construction of generators in Puerto Rico, such as those related to transportation of materials by sea from the U.S. mainland. PREPA has applied the sixteen percent (16%) adder to the capital cost of all technologies,[616] and so in this way the adder does not strongly shape the outcome of modeling that compares the different options. Fossil fuel generators are less capital-intensive (per kWh generated) than solar PV, because they also have a fuel

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[610] *Id.* at page 47.

[611] *Id.*

[612] The only new technology that was modeled without this cost adder was utility-scale energy storage.

[613] *See* Proposed IRP, page 6-11.

[614] U.S. Army Corps of Engineers, May 16, 2019. "DOD AREA COST FACTORS (ACF) PAX", page 1. Accessed at https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll8/id/4046.

[615] *See* Proposed IRP, page 6-23.

[616] Again, with the exception of utility-scale storage.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

cost, so PREPA's use of a uniform capital cost adder may slightly favor the fossil fuel options. PREPA does account for the cost to deliver fuel to Puerto Rico, as discussed in Part III(F). Even with the adder, solar PV generally remains less expensive than any of the fossil fuel options, on an LCOE basis, and PREPA has not applied the adder to the battery storage that accompanies solar PV. Therefore, the Energy Bureau concludes that the use of the cost adder has not had a strong or biased effect on the Action Plan of the Proposed IRP.

466. Considering the balance of the evidence in this proceeding, the Energy Bureau **FINDS** that the use of the uniform sixteen percent (16%) cost adder **IS ACCEPTABLE** for the planning purposes of the Proposed IRP. However, the Energy Bureau looks forward to the discovery of actual costs and prices that will come from the competitive solicitations envisioned in the Action Plan (and discussed in Part IV). Furthermore, for the next IRP, the Energy Bureau **ORDERS** PREPA not to rely on a cost factor of this sort, and instead base its analysis on the results of actual solicitations and market-available prices for development and installation in Puerto Rico.

b. Access to capital and cost of capital

467. All of the generation options examined in this Part are modeled as being financed with ratepayers paying for them over time. PREPA assumed a cost of capital of 8.5% for all options. PREPA assumed that the costs and benefits of each type of generator are independent of the generator's ownership structure. For a PPOA model, PREPA assumed that it would be an acceptable counterparty, allowing the project developer/owner to raise capital at the reasonable average cost of 8.5%. While PREPA remains in Title III Bankruptcy, it has limited and/or expensive access to capital markets, and it is unlikely to be regarded as a low-risk counterparty. We cannot know today what PREPA's creditworthiness will be when it emerges from bankruptcy, because that path is not yet known. Therefore, the costs of all generation options in this Part are subject to substantial uncertainty. We find, however, that paralysis in the face of this uncertainty is not an acceptable approach to planning for Puerto Rico's energy future. The Energy Bureau therefore **ACCEPTS** PREPA's assumption, for the purposes of the Proposed IRP process, that all generation options have the same affordable access to capital. The detailed pursuit of the Action Plan resulting from the Proposed IRP will necessarily be shaped by the Title III process, among many other factors, and the Energy Bureau will remain vigilant in its engagement with PREPA's fiscal health and the resulting impacts on resource procurement.

c. Fossil fuel generators

468. PREPA used an industry-accepted cost estimating tool, PEACE, to estimate the costs of the fossil-fuel powered generation options used in the IRP. PREPA describes the cost estimates that it produced as accurate to within negative fifteen percent (-15%) to

positive thirty percent (+30%) of possible final costs.[617] We understand that greater precision on costs would require substantial effort to specify the proposed projects in greater detail, and that this type of additional work is not warranted at the integrated resource planning level. While PREPA used the specifications of particular generators to develop indicative results, the Proposed IRP does not specify particular products or vendors in the Action Plan. Detailed procurement processes are intended to follow after the adoption of the Proposed IRP, as consistent with the approved Action Plan.

469. In her testimony, Ms. Sommer states that she believes that the costs for fossil fuel generators developed in the Proposed IRP are lower than the costs of similar generators identified in the public results of other utility planning processes.[618] The costs from other locations that Ms. Sommer identifies are within the negative fifteen percent (-15%) to positive thirty percent (+30%) range that PREPA identifies as the accuracy range of its estimate.[619] We agree with Ms. Sommer's observation that PREPA's use of a cost adder for Puerto Rico should imply that costs in Puerto Rico would be expected to be higher, on average, than costs on the mainland, rather than lower.

470. The Energy Bureau has considered Mr. Fladger's testimony regarding the cost of RICE generators and the value of their responsiveness, as well as Dr. Bacalao's responses regarding utility costs and modeling. The Energy Bureau understand that there is multi-way competition in the capacity expansion model, including between fast-response generators (such as RICE and GTs) and batteries to provide both ancillary services and to integrate variable renewables, and also between combined cycle plants, solar, RICE units, and others to provide energy generation. Correctly parametrizing each generation option as to both cost and performance is important for these competitions to be resolved. The Energy Bureau **ACCEPTS** Dr. Bacalao's explanation regarding the difference between the vendor's cost of RICE units (as provided by Mr. Fladger) and the utility's full cost, which is what should be modeled in the Proposed IRP.

471. After considering PREPA's filings and the testimony presented in the instant case (including that presented by Dr. Bacalao, Ms. Sommer, and Mr. Fladger), the Energy Bureau **ACCEPTS** PREPA's use of the input assumptions for costs and performance of RICE and combined cycle units for this planning process. The Proposed IRP is not a procurement process and it includes sensitivity analyses that reflect different potential futures, including different costs of fuel and generation technologies. The Energy Bureau understands the objective of the Proposed IRP modeling is to indicate paths forward that are robust against uncertainties, while allowing for subsequent processes to make the final detailed decisions. As detailed in the discussion of the Action Plan

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[617] *See* Proposed IRP, page 6-13.

[618] *Id.* at pages 21-22.

[619] Ms. Sommer cites a range in 2018 of $960/kW to $1101/kW (Sommer, pages 21-22), while PREPA assumes a present-day cost of $1096/kW (Sommer, page 21).

(Part IV), we expect that PREPA will design its procurement processes consistent with the approved IRP such that both turbine-based and RICE units can compete to provide combustion-based generation services, if those services are required as part of PREPA's energy supply portfolio.

472. Dr. Stanton claims that PREPA has failed to account for the need to retire all fossil fuel assets by 2050 when setting the amortization lifetimes for the fossil fuel generators under consideration in the Proposed IRP.[620] The Energy Bureau identified this potential issue even before the Proposed IRP was filed (reflecting the passage of Act 17) and ordered PREPA to avoid stranded costs by requiring all fossil fuel assets to be retired by 2050.[621] The Proposed IRP states that PREPA has done this accounting correctly,[622] and Dr. Bacalao reiterates this in his rebuttal testimony.[623] The Energy Bureau's examination of the evidence allows us to **CONCLUDE** that PREPA's analysis is sound on this point.

d. Onshore wind

473. In the Proposed IRP and supporting workpapers, PREPA presented hourly wind generation profiles (both modeled as measured from actual facilities) and utilized industry standard, vetted inputs for the cost trajectory and capacity factor of onshore wind turbines from NREL, tailored to the right level of wind resource for Puerto Rico. While several intervenors argued that wind is low cost and that wind offers a different generation profile than solar, no intervenor provided evidence that these statements are true for Puerto Rico. The Energy Bureau therefore **ACCEPTS** PREPA's assumptions regarding onshore wind for the purposes of planning in this IRP. However, the assumed costs do not reflect actual bids from real proponents. The Energy Bureau therefore **ORDERS** PREPA to ensure that all RFPs open to solar PV also allow onshore wind to compete. When evaluating wind RFP responses, PREPA must require data regarding the temporal profile of wind at the proposer's site and must compare the proposed wind resource against the combination of solar and batteries that would be able to deliver comparable energy and evening peak capacity.

e. Offshore wind

474. PREPA did not model offshore wind in the Proposed IRP. The evidence presented by Mr. Bannister indicates that offshore wind may have a load shape that is highly complementary to solar. A renewable resource that reliably produces substantial

[620] EDF, Direct Testimony of Dr. Elizabeth Stanton, October 23, 2019, page 24.

[621] Resolution and Order, In Re: Topics Discussed at April 1, 2019 Technical Conference and PREPA's Clarification Questions, Case No. CEPR-AP-2018-0001, April 5, 2019, page 4.

[622] *See* Proposed IRP, page 6-3.

[623] PREPA, Testimony of Dr. Nelson Bacalao, December 20, 2019, pages 9-10.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

output during the evening peak would be valuable in that it could avoid not only the cost of solar PV but also the cost of the storage necessary to shift that solar into the evening. We recognize that offshore wind is a relatively nascent industry in the United States, that floating wind turbines of the sort proposed by Mr. Bannister for use off the north coast of Puerto Rico are particularly novel, and that substantial marine and wind studies would be required before any offshore wind resource could be constructed in Puerto Rico. Nonetheless, Mr. Bannister's testimony convinces us that the potential benefits of offshore wind are considerable.

475. The Energy Bureau therefore **ORDERS** PREPA to conduct an offshore wind study tailored to Puerto Rico's wind resource and electric grid that evaluates the cost, generation profile, and other characteristics of anchored and floating wind turbine options, informed by industry experiences in Europe and the U.S., and submit the study to the Energy Bureau within two years from the date of this Final Resolution and Order. The study should consider locations on all sides of Puerto Rico while accounting for the value of locating generation closer to load (such as in the North). We further **ORDER** PREPA to solicit and incorporate feedback from the Energy Bureau regarding the scope for this study prior to issuing any RFP for the preparation of such study.

476. Regardless of the progress or results of the offshore wind study, the Energy Bureau **ORDERS** PREPA to ensure that all RFPs open to solar PV also allow offshore wind to compete. When evaluating offshore wind RFP responses, PREPA must require data regarding the temporal profile of wind at the proposed site and must compare the proposed wind resource against the combination of solar and batteries that would be able to deliver comparable energy and evening peak capacity.

f. Storage

477. PREPA's modeled costs and performance for utility-scale storage were not contested or questioned by intervenors in this proceeding. PREPA did not apply the sixteen percent (16%) DoD Area Cost Adder to utility-scale storage in its modeling, so intervenor concerns about this factor do not apply here. PREPA assumed that storage would be paired with solar and receive the benefits of the ITC. In order to be eligible for the ITC, a battery can be charged only from the solar array. This requirement could reduce the usefulness of the batteries, from a dispatch standpoint, although it is not likely to have a major effect on the Action Plan because the dominant use case of batteries in the Proposed IRP is to charge from solar and then dispatch to meet peak loads.

478. The Energy Bureau **ACCEPTS** the utility-scale battery energy storage cost and performance assumptions that PREPA made for the purposes of planning in the Proposed IRP. As with other technologies under consideration in this planning process, the Energy Bureau **ORDERS** PREPA to test the actual market-delivered price for energy storage, both as stand-alone installations and coupled with solar PV, through

competitive procurement processes prior to determining the specific investments to make or contracts to sign. The Energy Bureau further **ORDERS** PREPA to use the results of competitive procurement processes to establish and/or confirm the storage costs assumed for modeling in the all subsequent IRP proceedings.

479. PREPA did not explicitly consider distributed storage in the Proposed IRP, so it did not assign costs to the delivery of storage services by such assets. As discussed in the testimony of Mr. Rauscher, it is possible that storage services may be available from customers who have invested in storage as an individual resilience solution. It is also possible that such services may be less expensive when acquired from these customers than when acquired from utility-scale batteries. No parties have presented quantified costs or benefits for this approach in Puerto Rico in this proceeding. As discussed in the VPPs discussion later in this Part, and in the Action Plan (Part IV), the Energy Bureau **ORDERS** PREPA to use appropriate programmatic, market-based, and/or tariff-based tools to test the availability and cost of this distributed storage resource. Each of PREPA's new programs, tools, or tariff changes are, of course, subject to the Energy Bureau's review. To the extent that distributed storage resource is more cost-effective than utility-scale storage, the Energy Bureau **ORDERS** PREPA to utilize this resource. The Energy Bureau further **ORDERS** PREPA to use the results of its efforts to acquire distributed storage resources to provide grid services to inform its assumptions regarding the cost, availability, and performance of distributed storage in the next IRP proceeding.

480. The Energy Bureau has considered the arguments presented by EDF and PREPA regarding the use of annual deployment limitations for solar and storage. Throughout this process, we have been concerned that these limitations had the potential to unduly constrain the range of resource portfolios produced by PREPA's models. This is why we insisted on Scenario 3, with higher availability, as well as other sensitivity cases described in more detail in Part III(G). As described in Part III(G) and Part IV (Action Plan), the Energy Bureau has been able to use the results of the different scenarios to develop an adequate picture of the resource options facing Puerto Rico, including the extent of the impact from any limitations on PREPA's pace of interconnecting solar and battery systems. Part IV (Action Plan) further addresses actions PREPA must take to reduce or eliminate bottlenecks in the deployment of solar and storage.

g. Utility-scale solar PV

481. In the Proposed IRP and supporting workpapers, PREPA presented hourly solar generation profiles and utilized industry standard vetted inputs from NREL for the capital cost trajectory of utility-scale solar PV. PREPA made adjustments to the NREL costs for Puerto-Rico-specific land and interconnection costs. No party objected to the underlying utility-scale cost trajectories from NREL that PREPA used for this resource in the mid- and low-cost scenarios.

482. Several parties did, however, object to adjustments that PREPA made to these costs to translate them to levelized costs of energy. In particular, many parties objected to the use of the sixteen percent (16%) DoD Area Cost Adder. We addressed this adder earlier in this Part, as it applies to all generation technologies.

483. Ms. Sommer further objected to the use of the 1.3 AC to DC conversion factor to translate costs per kW_{DC} to costs per kW_{AC} as part of developing the LCOE. PREPA explained in its Reply Brief that this conversion factor is consistent with the definition of the capacity factor that PREPA used. Fundamentally, the question at issue here is what the capital cost of a generator will be relative to the amount of energy (kWh) that it will produce. We have evaluated the arguments presented, along with the definitions of the relevant terms as used by the parties and their sources (such as NREL). From this evaluation, we have determined that two calculations are equivalent:

1. Converting the cost per kW_{DC} to cost per kW_{AC} by multiplying by 1.3 and assuming a 22% capacity factor, where the capacity factor is defined as $kWh_{AC}/(kW_{AC}*8760hrs)$
2. Not converting the cost per kW to AC terms, while assuming a capacity factor of 22%/1.3 = 16.9%, where the capacity factor is defined as $kWh_{AC}/(kW_{DC}*8760hrs)$

484. PREPA performed the first of the two calculations above. Ms. Sommer assumes the latter (while assuming the value of the capacity factor would remain twenty-two percent (22%)). We understand that the second formulation is more common and is used in the NREL ATB. However, from the standpoint of a utility that interconnects with an asset as a source of AC power and capacity, using the AC capacity factor makes sense and PREPA has used it consistently within the Proposed IRP.

485. After considering the evidence presented in this proceeding, the Energy Bureau **ACCEPTS** PREPA's utility-scale solar PV costs as presented in the Proposed IRP, for the purposes of planning. As with each of the other generation technologies discussed in this Part III(E) of this Final Resolution and Order, PREPA lacks recent market-tested pricing for solar PV at the utility scale. Even in the few years since PREPA last solicited new solar PV projects, the cost of solar PV projects around the world has fallen substantially. As detailed further in Part IV (Action Plan) of this Final Resolution and Order, PREPA must test the market and determine up-to-date solar PV prices for development in Puerto Rico. The Energy Bureau **ORDERS** PREPA to use these processes both to acquire solar PV, and to develop prices for use in its next IRP analyses.

h. Distributed solar PV

i. DG deployment projection

486. PREPA did not consider distributed customer-sited solar PV as a resource that changes (in either cost or level of deployment) between scenarios. In effect, PREPA treats distributed solar PV as an exogenous and fixed set of resources whose deployment simply happens, and for which PREPA must account. In reality, PREPA has a substantial impact on the pace of deployment through its interconnection processes and rates, and it could further encourage or discourage customer-sited generation through programmatic approaches. For example, as Mr. González, Mr. Raucher, and Mr. Wilson testified, changes in the rate structure associated with the RSA could have substantial impacts on customer behavior.

487. PREPA presents a single trajectory for the adoption of distributed PV, which is built by fitting a national distributed PV adoption model to the historical pace of PV deployment in Puerto Rico. This is a reasonable starting point, because it incorporates broad, national trends. It is not tailored or specific to Puerto Rico, however, which has a unique combination of high rates, significant resilience concerns, and an excellent solar resource. PREPA's projection continues and slowly increases the Island's relatively high rate of DG installation throughout the planning period. PREPA states that this projection reflects the continued favorable economics of DG solar relative to utility-supplied energy. Intervenors criticize PREPA for not doing more to foster DG solar PV deployment, and not reflecting such activities in the forecast or scenarios.

488. Upon consideration of the various evidence and arguments presented by the parties, the Energy Bureau **FINDS** that PREPA's analysis of the DG resource using a fixed forecast is **ACCEPTABLE** for the limited purposes for which it is used in this proceeding. In effect, it does nothing but modify the load forecast. As discussed in Parts III(A) and III(B) of this Final Resolution and Order, the load forecast is highly uncertain across a number of dimensions (regarding economic growth and EE, for example). The amount of DG deployment is one more source of uncertainty for utility-scale resource planning. The Action Plan must be robust against uncertainties in the net load to be served by the utility, as discussed in Part IV of this Final Resolution and Order. This extends to being robust regarding different rates of customer adoption of DG. As further discussed below (under "grid defection") and in Parts III(I) and IV (Action Plan), distributed resilience solutions that use DG may be shaped by utility action or programs that could change the DG deployment trajectory. The Energy Bureau **ORDERS** PREPA to take these impacts into account in the next IRP.

ii. Cost of distributed PV

489. PREPA presents a calculation of the cost of distributed solar PV in order to evaluate how that cost compares to the cost of utility-supplied energy. This calculation shows

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

that self-supplied energy is less expensive than the retail rate, and this determination informs PREPA's assumption that DG deployment will continue at or above its historical rate.

490. Dr. Irizarry Rivera, by contrast, argues that distributed solar PV is not only less expensive than the retail rate, it is less expensive than utility-scale PV. However, Dr. Irizarry Rivera's argument for lower DG solar costs is not supported by the balance of the evidence. His testimony relies on simply removing the components of solar system cost for customer acquisition and profit. These costs, however, are necessary for a business to install solar PV and battery systems, as testified to by Mr. González and Mr. Rauscher. It is not reasonable to assume them away. Therefore, we conclude that it is reasonable to assume that distributed solar PV costs will be higher than Dr. Irizarry Rivera's projection.

491. Dr. Irizarry Rivera does not present actual installation costs, and instead bases his calculations on national-level NREL costs. His projections for DG solar costs fall substantially over time, extending down to a cost of 1.8 cents/kWh for rooftop solar PV installations in 2038. These values are not supported by the NREL ATB that is the nominal source of Dr. Irizarry Rivera's projection. The NREL Mid-case projection of distributed PV costs falls by about a factor of two between 2019 and 2038,[624] not the factor of approximately four that is included in Dr. Irizarry Rivera's projection.

492. Dr. Irizarry Rivera presents a vision for solar PV installation that does not rely on for-profit companies and is driven by motivated customers who do not need to be "acquired." We have not seen evidence in this proceeding that this vision is a reality in Puerto Rico, especially that this alternate approach could result in the hundreds of MWs of installation per year envisioned by the various scenarios modeled in the Proposed IRP. Nonetheless, as discussed below, all parties agree that solar PV and batteries are and will continue to be highly competitive with grid-supplied electric service for many customers. To the extent that solar PV deployment rates are faster in Puerto Rico due to adoption of a different model for solar installation, the Energy Bureau **ORDERS** PREPA to adapt its load forecast and procurement processes, as described in the Action Plan (Part IV).

i. Distributed vs. utility-scale solar PV and storage

i. Comparison of utility-scale and DG solar costs

493. Distributed solar PV has advantages and disadvantages with respect to utility-scale solar PV. Advantages of customer-sited solar PV include reduce line losses and the fact that PREPA's access to capital has little to no impact on its cost or availability (because

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[624] PREPA Workpaper, "S4S2B_Rate_Impact_v3.xlsm", sheet "Solar - PV Dist. Res", which is a duplication of the relevant portion of the 2018 NREL ATB.

customers or other third parties pay for and install it). The primary disadvantage is the lack of economies of scale, so the overall cost is higher on a per-kWh basis.

494. Intervenors state that rooftop solar is less expensive to develop than utility-scale, and so PREPA should choose rooftop. As discussed above, we do not accept the alternate assessments of the cost of distributed solar PV. In addition, the cost to PREPA (and thus to other ratepayers) is not the cost to deploy the rooftop PV; it is what the utility pays for the resource. PREPA has among the highest retail rates in the nation. With full retail net metering, as established by Act 17, PREPA is paying the equivalent of these high retail rates in order to acquire the rooftop solar resource, even if it costs the homeowner much less. Intervenors request active programs to promote DG,[625] yet the net metering paradigm already in existence offers a high rate of return if rooftop systems are as inexpensive as the Intervenors claim.[626] In order for rooftop PV to be the cost-effective resource to deploy at scale that the intervenors claim it would be, PREPA would need to be able to acquire its output for something close to its cost – that is, much less than the current retail rate.

ii. Grid defection

495. PREPA did not integrate its modeling of the costs of customer self-supply into its analysis, nor did it model customer behavior. PREPA shows that within the next decade it will be less expensive for a typical residential customer to fully supply their needs with solar and batteries than to get service from PREPA, yet PREPA did not take this fact into account when developing the DG adoption forecast or accounting for distributed storage. The Energy Bureau agrees with intervenor witnesses that, under current rate designs and policies, such customers would likely retain their grid connections in order to use the grid as backup supply (and potentially reduce wear and tear on batteries). As a result, customers might only install enough batteries and solar to ensure continuous energy to critical loads within their homes. Neither PREPA nor any Intervenor presented quantitative analysis of the impacts of changes in rate structure (including the provisions of the RSA) on the adoption trajectory. In the face of these uncertainties, the Energy Bureau **ORDERS** PREPA to include, in the next IRP, a model of DG solar and storage adoption that accounts for the impact of PREPA rates and programs, along with Puerto Rico public policy, and reflects the risk of grid defection.

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[625] For example, see LEOs, Final Brief, March 6, 2020, page 12.

[626] Customers have adopted storage alongside solar PV at a higher rate since Hurricanes Irma and María. This lowers the financial return, because the storage has a cost but is not compensated. The increasing pace of DG installations even in the face of higher costs indicates that customers are both able to afford solar PV with a lower rate of return, and also that customers value the resilience benefits of storage.

iii. Virtual power plants

496. No party has expressed opposition to the use of VPPs as a potentially cost-effective way to utilize distributed resources as utility assets. We see VPPs as a promising option for Puerto Rico because they can jointly meet customer desire for resilience, control, and ownership with a utility need for the grid services that DG and storage can provide (while also not requiring utility capital investment). VPPs also have the potential to reduce grid defection by increasing the value of grid connection relative to disconnection. In addition to stationary distributed batteries, electric vehicles (as discussed in Part III(A)) are a potential VPP resource, through controlled charging and the potential ability to provide power to the home and/or grid. EV adoption coupled with a VPP approach could shift the balance between utility-scale and distributed batteries that would otherwise be reflected in the Action Plan. As detailed further in Part IV (Action Plan), the Energy Bureau **ORDERS** PREPA to quickly pursue VPP approaches to capture the grid value of distributed resources through RFPs, tariffs, rates, and/or direct utility programs.

F. Assumptions and Forecasts

497. Section 2.03(G) of Regulation 9021 requires that the IRP document key modeling assumptions and inputs that include the annual fuel price for each delivered fuel in Puerto Rico.[627] Regarding fuel prices, Section 2.03(G)(2)(a)(v) requires the IRP to "develop a range of possible outcomes for those forecasts encompassing at least the fifth and ninety-fifth percentile outcomes as understood by PREPA."

1. PREPA Filing

a. PREPA fuel forecasts: commodity components

498. PREPA's fuel price forecasts are presented in Section 7.2 of the Proposed IRP and cover natural gas (Henry Hub), crude oil, Diesel (No. 2 fuel oil), residual fuel (No. 6 fuel oil with sulfur content of 0.5%, and coal prices. PREPA's delivered fuel prices are based on the pricing of various price hubs represented in the fuel forecast.

499. Because Puerto Rico has no fossil fuel resources, Puerto Rico is reliant on natural gas and other fuel imports from the US mainland or other foreign sources. Domestic fuel imports are restricted under the Jones Act, which limits the type of transport vessels that can deliver fuel to Puerto Rico. International imports are not restricted under the Jones Act. Both domestic and international imports reflect additional costs to deliver fuels into Puerto Rico. As a result, PREPA's fuel forecast can be divided into two

[627] *See* Regulation 9021.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

components. The first is the commodity price of the fuel. The second component is the delivered price, which is the price of the commodity plus transportation and profit.

i. Commodity price: natural gas

500. The Henry Hub price has been the U.S. natural gas price benchmark since the early 1990s, as it is the most highly traded natural gas pricing point in the United States. For many other trading points (hubs), Henry Hub serves as the foundation for the derivative pricing market. Other hubs trade the difference (the basis) between the price at another hub and the price at Henry Hub. The existing PREPA fuel contracts are based on Henry Hub price.

501. PREPA developed its forecast of Henry Hub price using RBAC Incorporated's Gas Pipeline Competition Model (GPCM®) that mathematically solves for gas prices as an output based on input for gas supply, pipelines, storage, and gas demand.[628] Siemens' license of the GPCM® model factors in future weather, economic growth, world oil prices, and energy infrastructure developments on a quarterly basis and in a semi-annual review.[629] The forecast developed for PREPA included natural gas production forecasting, iteration with electricity market modeling, and pipeline infrastructure assumptions.[630] A graphical representation of PREPA's natural gas price forecast, compared to other forecasts, is presented as Exhibit 7-7 in the IRP. The other forecasts include: AEO 2018, June 2018 futures, World Bank, GLJ Petroleum Consultants, Sproule Consulting, and IHS.[631] PREPA's forecast is lower than the EIA's AEO 2018 forecast, and lower than many of the other forecasts for the first three years (2018-2020). In later years, the PREPA forecast falls in the mid-range of the presented forecasts.[632]

502. PREPA used statistical analysis of Henry Hub natural gas prices to develop high and low gas prices that are one standard deviation above and below the base gas price, as well as 5th percentile and 95th percentile prices.[633]

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[628] RBAC, Inc., *GPCM® Natural Gas Market Forecasting System™*, https://rbac.com/gpcm-natural-gas-market-model/ GPCM is a proprietary model used in the energy modeling industry.

[629] RBAC, Inc., *GPCM® Base Case Briefing,* https://rbac.com/gpcm-base-case-natural-gas-forecast-briefing/

[630] RBAC, Inc., *GPCM® Frequently Asked Questions*, https://rbac.com/gpcm-natural-gas-market-model-faq/. The iteration of a gas and electricity prices is frequently used since the models are usually distinct from each other.

[631] *See* Proposed IRP, page 7-20.

[632] Several of the forecasts do not go beyond 2030. Only two forecasts (AEO 2018 and IHS) extend to 2040. The PREPA forecast is lower than both forecasts starting in 2028.

[633] *See* Proposed IRP, pages 7-26 to 7-32.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

ii. Commodity price: crude oil

503. PREPA's forecast of commodity crude oil prices (West Texas Intermediate, or WTI)) is based on a comparison and average of a variety of forecasts including EIA and the International Energy Agency (IEA).[634] A graphical representation of the PREPA crude oil price forecast compared to other forecasts is presented as Exhibit 7-9 in the IRP. The other forecasts include: AEO 2018, June 2018 futures, World Bank, GLJ Petroleum Consultants, and Sproule Consulting.[635] For the first three years (2018-2020), PREPA's forecast is one of the highest forecasts. In later years, the PREPA forecast falls in the mid-range of the presented forecasts.[636]

iii. Commodity price: fuel oils

504. PREPA adapted the crude oil forecasts to develop fuel forecasts for diesel, residual fuel oil, and liquified petroleum gas (LPG) based on a regression of the historical relationship of these fuel prices to WTI prices.[637]

iv. Commodity price: coal

505. PREPA's forecast of coal prices (Columbia) is based on Siemen's outlook on Illinois Basin coal prices and the historical price relationship between Illinois Basin and Columbia coal.[638]

b. Delivered fuel prices

506. PREPA uses the commodity fuel price forecasts to forecast delivered fuel prices at PREPA's power plants. The delivered price reflects adders for transportation, margin, and liquification for LNG. The following sub-parts detail the delivered fuel prices used in the Proposed IRP.

i. Delivered fuel price: natural gas

507. PREPA provided two cost adders for delivered natural gas prices for specific plants.

[634] *See* Proposed IRP, page 7-23.

[635] *Id.* at page 7-23.

[636] Several of the forecasts do not go beyond 2028. Only the AEO 2018 forecast extends to 2040. The PREPA forecast is lower than AEO 2018 starting in 2020.

[637] *See* Proposed IRP, page 7-25.

[638] *Id.* at page 7-24.

508. In the IRP, PREPA used the following formula for Costa Sur:[639] [640]

509. Delivered price = (12.15% New York Harbor No. 6 fuel price + $1.125/MMBtu) * 50% + (115% Henry Hub +$5.95/MMBtu)

510. However, in response to ROI 10-09, PREPA provided the updated negotiated delivery cost for the delivered natural gas for Costa Sur as summarized below:[641]

2020: 115% Henry Hub + $5.80/MMBtu

2021: 115% Henry Hub + $5.70/MMBtu

2022: 115% Henry Hub + $5.60/MMBtu

2023-32: 115% Henry Hub + $5.50/MMBtu

511. For San Juan 5 and 6, Palo Seco, Mayagüez, and Yabucoa, PREPA used a formula to represent ongoing contract negotiations.[642] This formula was:

Delivered price = 115% Henry Hub price + $4.35/MMBtu

512. PREPA indicates that the breakdown of the $4.35/MMBtu fuel adder for San Juan 5 and 6 consisted of $1.00/MMBtu for transport, $0.55/MMBtu for margin, and $2.80/MMBtu for liquefaction.[643] PREPA's estimate for the delivery adders is based on its review of adders currently seen from LNG sourced from Trinidad and Tobago.[644]

513. In the Proposed IRP, PREPA described that it had executed a five-year contract to convert San Juan 5 and 6 to burn natural gas and to purchase LNG from New Fortress Energy.[645,646] The exact pricing for the New Fortress Energy LNG contract was not explicitly noted in the Proposed IRP. In ROI 01-38 Attachment 1, PREPA provided a

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[639] *Id.* at page 7-25.

[640] Naturgy Aprovisionamientos SA (Naturgy) currently provides natural gas to its EcoEléctrica facility and PREPA's Costa Sur plant. On November 5, 2019, PREPA filed a petition before the Energy Bureau titled "*Request for Approval of Amended and Restated Power Purchase Agreement with EcoEléctrica and Natural Gas Sale and Purchase Agreement with Naturgy; Request for Confidential Treatment of this Letter and Accompanying Attachments.*" The Energy Bureau subsequently opened Case NEPR-AP-2019-0001 to address PREPA's petition outside the Proposed IRP. On March 11, 2020, the Energy Bureau issued a Resolution and Order approving the November 5 proposed agreement filed by PREPA.

[641] Energy Bureau's ROI 10, December 13, 2019.

[642] *Id.*

[643] *See* Proposed IRP, page 7-26.

[644] *Id.* at page 7-26.

[645] *Id.* at page 7-10.

[646] In its Resolution and Order dated October 4, 2018, in case CEPR-AI-2018-0001, the Energy Bureau determined that PREPA could continue its negotiations with New Fortress Energy to convert San Juan Units 5 and 6 to burn natural gas and to provide a fuel supply contract for the converted units.

copy of the executed contract that contained the specific pricing for the New Fortress Energy contract.[647] The contract pricing for LNG is as follows:

Delivered price: 115% Henry Hub + $8.50/MMBtu (Months 1-12)

Delivered price: 115% Henry Hub + $7.50/MMBtu (Months 13-24)

Delivered price: 115% Henry Hub + $6.50/MMBtu (Months 25-60)

514. The New Fortress Energy contract also includes a monthly capacity charge of $833,333.33 for the duration of the five-year contract as provided in ROI 1-38, Attachment C.[648]

ii. Delivered fuel price: other fuels

515. PREPA notes that the delivered fuel price for fuel oil, diesel, coal, and LPG were based on adders from current contracts provided by PREPA's Fuels Office.[649] The prices for delivered fuel specific to PREPA's generation units are summarized in Exhibits 7-11, 7-12, 7-13, and 7-14.[650]

c. Fuel forecast range

516. Section 2.02(G)(2)(a)(v) of Regulation 9021 requires PREPA to "develop a range of possible outcomes for those forecasts encompassing at least the fifth and ninety-fifth percentile outcomes." PREPA indicated that it developed a low and high delivered LNG scenario using a plus or minus one standard deviation band around its expected Henry Hub commodity price.[651] PREPA provides summary charts showing the range of delivered fuel prices for Aguirre, San Juan, Palo Seco, Mayagüez, Yabucoa, Costa Sur, EcoEléctrica in Exhibits 7-11, 7-12, 7-13, and 7-14.

2. Intervenors

517. Parties' comments on the use of natural gas or other fuels are detailed in Parts III(D), III(G), and IV. This Part solely focuses on the price trajectory of natural gas and other fuels.

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647 Energy Bureau's ROI 1, July 11, 2019.

648 *Id.*

649 *See* Proposed IRP, page 7-25.

650 These exhibits also include delivered fuel price ranges for coal, fuel oil, LPG, diesel, and coal.

651 *Id.* at page 7-26.

a. AES-Puerto Rico

518. AES-PR Witness, Mr. Ronald Moe, points to "unreported capital costs" associated with the development of the associated infrastructure to deliver containerized natural gas to the small GTs across the island in the S4S2B and ESM scenarios.[652] Specifically, Mr. Moe references the costs associated with the delivery and transport of LNG containers that would be required for each of the 18 proposed mobile 23 MW GTs in the ESM plan. AES-PR Witness Ms. Kristina Lund also noted that the AES facility could be redeveloped to burn natural gas.[653]

b. Arctas

519. In its Final Brief, Arctas comments that the Naturgy adder for Costa Sur is higher than PREPA assumed in the IRP.[654] Arctas contends that PREPA failed to receive market-based LNG prices for the renegotiated Naturgy contract.[655]

520. In its Final Brief, Arctas recommended that any future LNG infrastructure project be under a competitive bidding process.[656]

c. Empire Gas Company, Inc.

521. Empire Gas Company, Inc. (Empire Gas) witness Mr. Ramón González Simounet states that the propane prices have declined, not increased as shown in the IRP. [657] [658] Mr. Simounet references spot prices for propane from January 2018 ($0.90 per gallon) to October 2019 ($0.46 per gallon).[659] Mr. González Simounet provides an IHS Market forecast of propane prices through 2030.[660] Mr. González Simounet comments that PREPA should have factored surplus market conditions of LPG supply rather than the historical regression analysis used by PREPA to forecast propane prices.[661]

522. Expert witness, Mr. Ramón González Simounet, notes that PREPA's estimates for fuel costs for oil combustion plants shown in IRP Exhibit 4-1 are approximately 58% to 65%

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[652] AES-PR, Direct Testimony of Ronald Moe, October 23, 2019, page 20.

[653] AES-PR, Direct Testimony of Kristina Lund, October 23, 2019, page 3.

[654] Arctas, Final Substantive and Legal Brief, March 6, 2020, page 4.

[655] *Id.* at page 18.

[656] Arctas, Final and Substantive Brief, March 6, 2020, page 1.

[657] Empire Gas, Direct Testimony of Ramón González Simounet, October 14, 2019, page 33.

[658] Mr. Simounet uses propane and LPG interchangeably in his testimony. While propane is an LPG, LPG may contain other hydrocarbons other than propane.

[659] Empire Gas, Direct Testimony of Ramón González Simounet, page 33.

[660] *Id.* at page 35.

[661] *Id.*

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

higher than Empire Gas's estimate for wholesale LPG costs.[662] Mr. González Simounet concludes that the spread differential between LPG and other fuels is appropriate.[663]

523. Mr. González Simounet describes the existing synthetic natural gas (SNG) and liquified propane gas infrastructure currently available in Puerto Rico. Mr. González Simounet notes that LNG infrastructure is more expensive and complicated than SNG or liquified propane infrastructure.[664] Mr. González posits that Liquified Propane/SNG based generation is an ideal alternative for an island system and cites the World LPG Association.[665]

524. Mr. González Simounet notes that the Jones Act limits natural gas imports to the island.[666] The exception he notes is EcoEléctrica, as it receives its LNG from Trinidad and Tobago. Mr. González Simounet also notes that EcoEléctrica is already connected via pipeline to Empire's LPG import terminal and storage facility; and that the plant occasionally runs on LPG when the natural gas storage facility is down for maintenance and/or repairs.[667]

525. Mr. González Simounet notes that the Proposed IRP's Preferred Resource Plan relies on the development of natural gas infrastructure, but that there is a history of failed natural gas conversion development in Puerto Rico.[668] However, Mr. González Simounet does not document the historical evidence to support his claim. It appears that his concern is that without the development of the natural gas infrastructure, PREPA may need to rely upon the delivery of LNG from containerized trucks that would be filled and delivered from the mainland. According to Mr. González Simounet, this could impact the reliability of the GTs under the same reliability scenarios (*e.g.*, hurricanes) that they were designed to operate.[669]

526. Mr. González Simounet recommends that the Proposed IRP be amended to include liquified propane/SNG options and that the existing and new peaking units be converted to run on liquified propane/SNG.[670] In addition, Mr. González Simounet recommends that the proposed Yabucoa and Mayagüez terminals, and associated units,

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[662] Empire Gas, Direct Testimony of Ramón González Simounet, October 15, 2019, page 17.

[663] *Id.*

[664] *Id*. at page 8.

[665] *Id*. at page 13.

[666] *Id.* at page 19.

[667] *Id.*

[668] *Id*. at page 30.

[669] *Id.*

[670] *Id*. at page 38.

be supplied with liquified propane instead of LNG.[671] In its Final Brief, Empire Gas reiterated Mr. González Simounet's recommendation.[672]

d. Environmental Defense Fund

527. EDF's witness Dr. Stanton notes that the Henry Hub price is inappropriate to use for Puerto Rico since the island's gas is purchased from Trinidad and Tobago due to the lack of Jones Act compliant LNG transport vessels.[673] Dr. Stanton contends that PREPA failed to account for the Jones Act in its modeling.[674]

528. Dr. Stanton notes that the Proposed IRP fails to account for important financial risks posed to both PREPA and Puerto Rico residents resulting from the proposed investment of new gas infrastructure.[675] Specifically, Dr. Stanton highlights that PREPA's proposed resource plan calls for $2.6 billion of new gas infrastructure investments over the Proposed IRP planning period. If some of those capital expenditures are stranded by 2050, Dr. Stanton expresses concern that those stranded costs would negatively impact PREPA's and Puerto Rico's financial situation.[676]

529. In its Final Brief, EDF recommended that the Energy Bureau reject the Yabucoa and Mayagüez ship-based LNG facilities.[677]

e. Local Environmental Organizations

530. Dr. Agustín Irizarry Rivera states that he believes PREPA is using an overly optimistic natural gas price and that this incorrect natural gas price impacts all other issues.[678] Specifically, Dr. Irizarry Rivera's calculations estimate that delivery natural gas costs of $4.35/MMBtu in the Proposed IRP is too low.[679] He then references the 2019 delivered natural gas costs from the Proposed IRP and estimates that the New Fortress delivered price for natural gas is approximately $12/MMBtu based on the parameters of the

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[671] *Id*. at page 40.

[672] Empire Gas, Final Brief, March 6, 2020, page 7.

[673] EDF, Direct Testimony of Dr. Elizabeth A. Stanton, Exhibit B, October 23, 2019, page 36.

[674] *Id.* at page 36.

[675] EDF, Direct Testimony of Dr. Elizabeth A. Stanton, October 23, 2019, Exhibit B: Puerto Rico Integrated Resource Plan: Lessons from Hawaii's Electric Sector, October 22, 2019, page 3.

[676] EDF, Direct Testimony of Dr. Elizabeth A. Stanton, Exhibit B, page 36.

[677] EDF, Final Brief, March 6, 2020, page 1.

[678] LEOs, Direct Testimony of Agustín Irizarry Rivera, October 22, 2019, page 5.

[679] *Id.* at pages 22-23.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

contact and the inclusion of the fixed unit conversion cost of $833,333 per month for the first sixty (60) months of the contract.[680]

531. Ms. Sommer contends that PREPA understated the price of natural gas.[681] She also notes that model natural gas prices are not consistent with New Fortress prices.[682] In addition, Ms. Sommers notes that PREPA's $4.35/MMBtu delivery cost is kept constant in nominal dollars, which reflects a decline in real dollars.[683] Ms. Sommers contends that the last year of the New Fortress Energy contract should be the best indicator for the liquefaction and transportation adder for natural gas.[684] Finally, Ms. Sommers notes that PREPA did not rerun any of the plans using higher gas prices (Sensitivity 5).[685]

532. In its Final Brief, LEOs noted that the Energy Bureau should reject PREPA's Action Plan recommendation to proceed with the permitting of the Yabucoa and Mayagüez ship-based LNG facilities.[686] LEOs also noted that it would not be optimal for the island to have four natural gas import points as proposed under PREPA's Action Plan.[687] LEOs also expressed concerns regarding safety risk at San Juan harbor associated with increased LNG traffic.[688]

f. Not-for-profit intervenors

533. Expert witness Eric Ackerman recommends minimal investment in LNG supply infrastructure until after results of advanced grid planning methods are available.[689] Specifically, Mr. Ackerman notes that the investments in natural gas infrastructure will make it difficult to displace and eventually eliminate fossil fuel generation.[690] Mr. Ackerman contends that PREPA is proposing what amounts to a natural gas future, not

[680] *Id.* at page 23.

[681] LEOs, Direct Testimony of Anna Sommers, October 22, 2019, page 23.

[682] *Id.* at page 23.

[683] *Id.* at page 24.

[684] *Id.* at page 24.

[685] *Id.* at page 25.

[686] LEOs, Final Brief, March 6, 2020, page 44.

[687] *Id.* at page 53.

[688] *Id.* at page 57.

[689] NFPs, Direct Testimony of Eric Ackerman, October 22, 2019, page 4.

[690] *Id*. at page 11.

a renewable energy future, as required by Act 17.[691] In their Final Brief, the NFPs noted that LNG infrastructure costs are uncertain due to seismic risk.[692]

3. PREPA Rebuttal Filing

534. Dr. Nelson Bacalao's rebuttal testimony refutes LEOs' witness Irizarry-Rivera's claim that the New Fortress Energy contract for San Juan Units 5 and 6 results in a delivered natural gas price of $12/MMBtu by including New Fortress Energy's monthly charge of $833,333 for conversion and regasification.[693] Dr. Bacalao contends that the regasification costs are modeled separately in the Proposed IRP and that the cost of delivered gas reported in the IRP is the cost of commodity plus liquefaction and transportation.[694]

4. Amicus Curiae

a. Rocky Mountain Institute

535. In its *Amicus Brief*, RMI noted the justification for the fuel conversion of San Juan 5 and 6 relied on a higher capacity factor - ninety percent (90%) than that used by RMI.[695] Separately, RMI notes that its research found that sixty-seven percent (67%) of liquefaction projects experienced cost overruns, and that those projects experienced overruns of approximately seventy percent (70%).[696] RMI also notes that PREPA's fuel infrastructure estimates are static, and do not include the risk of capital cost overruns.[697]

5. Discussion

a. Fuel prices

536. The natural gas price forecast underpins the resource decisions and costs of the Proposed IRP. The trajectory of natural gas prices is driven by supply and demand components that fluctuate. The first component of natural gas price is the commodity component or the Henry Hub price trajectory.

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[691] *Id*. at page 19.

[692] NFPs, Closing Argument and Brief, March 6, 2020, page 17.

[693] PREPA, Rebuttal Testimony of Dr. Nelson Bacalao, December 20, 2019, page 19.

[694] *Id*. at pages 19 and 20.

[695] RMI, *Amicus Curiae* Brief, September 20, 2019, page 15.

[696] *Id.* at page 18.

[697] *Id.*

i. Natural gas price: commodity

537. PREPA's Henry Hub price is based on June 2018 forwards and is used for the first 18 months of the PREPA natural gas forecast.[698,699] While the Energy Bureau understands that there needs to be a cutoff date in assumptions to incorporate in the development of the 35 cases presented in the Proposed IRP, the Energy Bureau also notes that the natural gas prices used in the Proposed IRP were developed a full year before the publication of the Proposed IRP in June 2019. In response to ROI 4-8, PREPA provided a chart comparing the forwards as of August 2019 to the Base and Low case forwards from the Proposed IRP. The forward prices at that time were generally closer to the Low case prices presented in the Proposed IRP.

538. At the time of this writing, actual Henry Hub prices for 2020 are shown in the table below:

Table 5. Monthly Henry Hub Prices (January – May 2020)

Month	Price ($/MMBtu) Nominal
January	$2.02
February	$1.91
March	$1.79
April	$1.74
May	$1.75

539. These current prices reflect the impacts of the COVID-19 pandemic and resulting economic slowdown. For the next 12 months, the NYMEX Henry Hub forwards as of June 18, 2020, are presented below:

Table 6. Monthly Henry Hub NYMEX Futures (July 2020 – June 2021) ($/MMBtu)[700]

Month	Price ($/MMBtu) Nominal
July	$1.67
August	$1.75
September	$1.81
October	$1.91
November	$2.32
December	$2.81
January 2021	$2.95
February 2021	$2.92

698 *See* Proposed IRP, page 7-20.

699 The June 2018 forwards were based on average prices on May 7, 14, and 21 as confirmed in PREPA's Response to ROI 4-8 from the Energy Bureau, August 1, 2019.

700 Pricing from NYMEX future as of June 19, 2020.

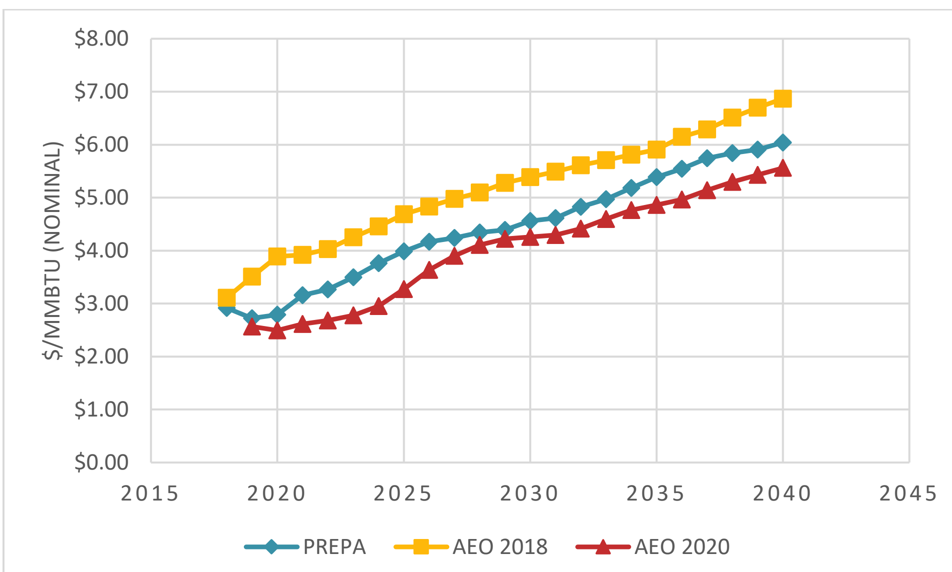
NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Month	Price ($/MMBtu) Nominal
March 2021	$2.81
April 2021	$2.52
May 2021	$2.48
June 2021	$2.51

540. The current forwards through 2021 track similarly to the forwards updated by PREPA in response to ROI 4-9 in August 2019.[701] The short-term impacts of the COVID-19 pandemic may result in low monthly gas prices that could continue for several months. This situation could result in lower natural gas prices for several years as there is uncertainty to the timing and trajectory of any economic recovery.

541. In the Proposed IRP, PREPA noted that the forwards were used for the first 18 months of the Proposed IRP period and then blended with its longer-term forecast for the next 18 months.[702] PREPA's longer term natural gas forecast was lower than the AEO 2018 forecast. In January 2020, EIA released AEO 2020, which contained an updated natural gas forecast but does not account for the current impacts of the COVID-19 pandemic.[703] The following graph compares PREPA's Proposed IRP forecast with AEO 2018 and AEO 2020.

Figure 6. Henry Hub Forecast: PREPA, AEO 2018, and AEO 2020 ($/MMBtu nominal)



[701] Energy Bureau's ROI 4, August 1, 2019.

[702] *See* Proposed IRP, page 7-20.

[703] U.S. Energy Information Administration, Annual Energy Outlook 2020, https://www.eia.gov/outlooks/aeo/.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

542. PREPA's Proposed IRP natural gas prices are between the AEO 2018 (higher) and AEO 2020 (lower) values. At this time, PREPA's commodity price for natural gas appears reasonable given the uncertainty surrounding the impact of COVID-19 and the global demand for natural gas. Accordingly, the Energy Bureau **ACCEPTS** the Proposed IRP base natural gas fuel forecast.

543. Section 2.02(G)(2)(a)(v) of the Regulation 9021 requires the IRP to "develop a range of possible outcomes for those forecasts encompassing at least the fifth and ninety-fifth percentile outcomes as understood by PREPA." In the Proposed IRP, PREPA's Sensitivity 5 represented high gas prices.[704] PREPA modeled five cases using the high gas price sensitivity as shown in Exhibit 5-4.[705] Our analysis of the metrics files for the five cases indicates that PREPA's higher gas price was not an input to the capacity expansion model, but was applied to the output of the model results to adjust the fuel cost values in the metric files.[706] In other words, rather than have higher gas prices dictate how the model chooses specific resources. The application of higher gas prices to the output of the model merely increases costs to the build-out of the analyzed model scenario. Although actual natural gas prices are currently trending lower than PREPA's base natural gas forecast, PREPA's high gas price methodology fails to reflect how higher natural gas prices would impact the Proposed IRP is appropriate and reflects the risk that gas prices could rise above the levels currently expected. Although it was not used for any sensitivities, PREPA's low gas price forecast (based on the 5th percentile) is also reasonable and reflects the fact that gas prices are more likely to rise substantially than to fall by the same amount. The Energy Bureau **ACCEPTS** PREPA's development of a range of possible outcomes for natural gas prices for use in this IRP analysis.

ii. Crude oil price forecast

544. PREPA's forecast of commodity crude oil prices (WTI) is based on a comparison and average of a variety of forecasts including EIA and IEA.[707] As noted above, PREPA provided a comparison of its WTI crude oil forecast with AEO 2018. AEO 2020 contains an updated crude oil forecast but, as stated above, does not account for the current

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704 *See* Proposed IRP, page 5-7.

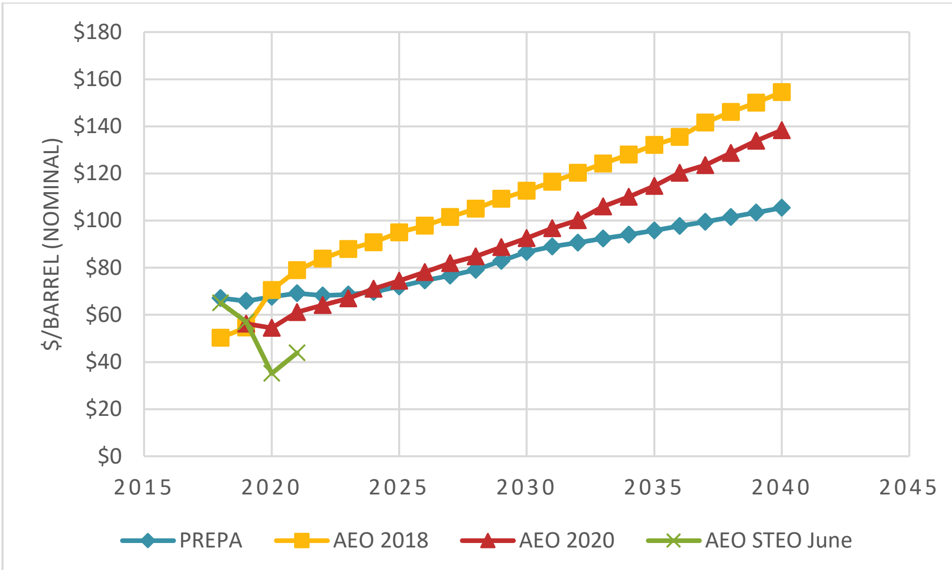
705 *Id.* at page 5-9.

706 It appears that PREPA calculated the impact of higher gas prices by pasting into the Metrics spreadsheet a table of numbers (not formulas) labeled "from CR5". These numbers appear to be the average fuel cost for energy generated by different plants/fuels in each year. PREPA then calculated the ratio between the values in the "from CR5" table and the average Fuel Cost in the modeled case (with base gas prices). PREPA then multiplied the resulting ratio by the Total_Fuel_Cost for each generator to create updated fuel costs. The updated fuel costs then replace the fuel costs in the calculation of the annual Total Costs.

707 *See* Proposed IRP, page 7-23.

impacts of the COVID-19 pandemic.[708] The EIA publishes a short-term energy outlook (STEO) that does reflect some impacts of COVID-19 on supply and demand.[709] The following graph compares PREPA's Proposed IRP forecast with AEO 2018, AEO 2020, and STEO (June).

Figure 7. WTI Forecast: PREPA, AEO 2018, AEO 2020, and STEO June 2020 ($/barrel nominal)



545. PREPA's IRP crude oil price forecast is between the AEO 2018 (higher) and AEO 2020 (lower) values for the first few years. All three forecasts are much higher than the short-term outlook through 2021. Beyond 2025, PREPA's forecast is lower than both the AEO 2018 and AEO 2020 forecast. At this time, PREPA's crude oil appears reasonable given the uncertainty surrounding the impact of COVID-19 and the global demand for crude oil. Accordingly, the Energy Bureau **ACCEPTS** the IRP's crude oil fuel forecast.

b. Natural gas price: delivered

546. The delivered price of natural gas to specific units is a function of transportation, delivery, and profit negotiated in contracts executed by PREPA. These are all added to the commodity price of natural gas. In the Proposed IRP, PREPA uses a delivered natural gas price adder of $4.35/MMBtu for the San Juan, Palo Seco, Mayagüez, and Yabucoa plants.[710]

[708] U.S. Energy Information Administration, *Annual Energy Outlook 2020*, https://www.eia.gov/outlooks/aeo/.

[709] U.S. Energy Information Administration, *Short-term Energy Outlook*, https://www.eia.gov/outlooks/steo/.

[710] *See* Proposed IRP, page 7-25.

547. In response to Energy Bureau's ROI-1-38, PREPA acknowledged that the New Fortress Energy contract for the delivered natural gas price for San Juan Units 5 and 6 differed from what was filed in the Proposed IRP.[711] The Energy Bureau's Resolution and Order of October 4, 2018, in case CEPR-AI-2018-0001, accepted the New Fortress Energy conversion of San Juan Units 5 and 6. In response to Energy Bureau's ROI 7-1, PREPA re-ran the ESM scenario with current New Fortress Energy delivered natural gas prices.[712]

548. In addition to the transportation, delivery, and profit adders identified by PREPA, the Energy Bureau notes that LEOs' witness, Dr. Agustín Irizarry Rivera, contended that the New Fortress Energy monthly $833,333 capacity cost should also be included as an additional adder for the delivered price of natural gas for the San Juan units.[713] In response, PREPA witness, Dr. Nelson Bacalao, contends that the $833,333 monthly capacity costs represent the recovery of the New Fortress Energy's conversion costs for San Juan 5 and 6 and should not be included as a fuel cost, but have been modeled in the Proposed IRP as fixed costs.[714] That monthly cost is irrespective to the amount of natural gas that is actually consumed at the plant. This assertion is consistent with PREPA's response to LEOs' ROI 2-24 that indicated that the cost of vaporization is treated as a fixed O&M associated with the project.[715] In response to ROI 7-01 (b), however, PREPA indicated that the gasification costs were included in the updated New Energy Fortress costs.

549. We note that PREPA's metric filings for the San Juan 5 and 6 conversion resources contain a column for an additional fixed cost that closely matches the annualized value of the $833,333 monthly capacity cost referenced in the New Fortress Energy contract. For a new LNG landing facility such as those proposed for Yabucoa and Mayagüez, PREPA indicated that the gasification costs associated would be fixed costs that would not be reflected in the delivered natural gas price.[716] In response to LEOs' ROI 2-24(e), PREPA indicated that it anticipated that the pricing for Yabucoa and Mayagüez would be the same as for San Juan.[717]

550. The Energy Bureau notes that PREPA's adders for transportation, liquefaction, and margin remain constant in nominal terms in its supporting workbooks and as stated in

[711] Energy Bureau's ROI 1, July 11, 2019.

[712] Energy Bureau's ROI 7, September 12, 2019.

[713] LEOs, Direct Testimony of Agustín Irizarry Rivera, October 22, 2019, page 5.

[714] PREPA, Rebuttal Testimony of Dr. Nelson Bacalao, December 20, 2019, page 19.

[715] LEOs, ROI 2, August 26, 2019.

[716] Energy Bureau's ROI 7, September 12, 2019.

[717] LEOs, ROI 2, August 26, 2019.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

the Proposed IRP.[718] As noted by LEOs' witness, Ms. Sommers, this treatment has the effect of lowering the impact of the adder in real terms since only the Henry Hub price escalates with inflation. In real terms, the adder component of the delivered prices will decrease in the future.

551. For current and existing contracts, PREPA's use of current contract terms is appropriate since those are the in-place contracts. We do note that PREPA's adder estimates for delivered natural gas prices did not incorporate high- or low-cost estimates for liquefaction, transportation, and margin costs in its analysis for either US or non-US sources of natural gas as detailed in ROI 2-26.[719]

552. For future contract prices, the available data points are the contracts between PREPA and its suppliers. In the case of the San Juan units, the executed contract provided by PREPA indicates that during the Extension Term (after the initial term of sixty (60) months), the unit cost for natural gas will be determined between PREPA and New Fortress Energy, subject to the Energy Bureau's approval.[720] For Costa Sur, PREPA and Naturgy renegotiated the Costa Sur natural gas delivery contract and the EcoEléctrica PPOA as detailed in the response to ROI 10-2.[721] The renegotiated delivered natural gas price for Costa Sur would start at one-hundred and fifteen percent (115%) of Henry Hub + $5.85 and end in 2032 at one-hundred and fifteen percent (115%) of Henry Hub plus $5.50.[722] These delivered prices are higher than the natural gas adders included in the Proposed IRP original filing.

553. During the Evidentiary Hearings, PREPA indicated that the Costa Sur gas price is comparable to natural gas prices at other locations.[723]

554. In response to Energy Bureau's ROI 10-5, PREPA re-ran a number of the key scenarios (including S1S2, S23S2, S4S2, and S5S1) using updated delivered natural gas prices for EcoEléctrica, Costa Sur, and San Juan 5 and 6.[724] The modeled runs also included No EE, Low EE, and solar assumptions modifications. The re-run scenarios provide an updated assessment of the Proposed IRP as discussed in more detail in Part III(G) of this Final Resolution and Order.

555. The Energy Bureau **ACCEPTS** the Proposed IRP baseline delivered natural gas price for San Juan and Costa Sur based on the updated modeling runs provided by PREPA. For

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[718] *See* Proposed IRP, page 7-26 and Workpaper, "PREPA Fuel Forecast 06032019_Final_with formulas.xlsx".

[719] Energy Bureau's ROI-2-26, July 18, 2019.

[720] ROI 1-38, Attachment 1, Exhibit C, July 11, 2019.

[721] Energy Bureau's ROI 10, December 13, 2019.

[722] *Id.*; *see also* ROI 10-9.

[723] Evidentiary Hearing, afternoon session, February 3, 2020, 3:12:46.

[724] Energy Bureau's ROI-10, December 13, 2019.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

future import sites such as ones proposed for Mayagüez and Yabucoa, the initial terms of the New Fortress Energy and Naturgy contracts are better indicators of initial delivered natural gas prices.

c. Fuel infrastructure

556. In Section 7 of the Proposed IRP, PREPA summarized the current state of LNG terminals. PREPA notes that there are currently no Jones Act-compliant large-scale LNG vessels.[725] PREPA notes that Puerto Rico currently receives a majority of its LNG supply from Trinidad and Tobago.[726]

557. PREPA's Proposed IRP includes assumptions for new fuel infrastructure facilities to gasify increased deliveries of LNG in the future. PREPA's action plan assumes that Puerto Rico's consumption of LNG increases to no more than 6.5 million metric tons per annum (MMtpa).[727] The Proposed IRP notes that EcoEléctrica's current contract for LNG from Trinidad and Tobago is about 0.5 MMtpa or about 24 bcf.[728] In order to supply the proposed increases in natural gas consumption, PREPA modeled the expansion and development of new gas infrastructure facilities.

558. Exhibit 7-4 of the Proposed IRP shows a summary of PREPA's assessment of fuel infrastructure options. Exhibit 7-4 describes ship- and land-based LNG options, reporting on costs, fuel volume capabilities, and maximum capacities. In the Proposed IRP, PREPA listed eight natural gas infrastructure options that it determined could be available:[729]

- Aguirre Offshore GasPort (AOGP);
- Ship-based LNG at San Juan with pipeline to Palo Seco;
- Land-based LNG at San Juan with pipeline to Palo Seco;
- Ship-based LNG at Mayagüez (West);
- Ship-based LNG at Yabucoa (East);
- LNG or compressed natural gas (CNG) delivery to San Juan and potentially Palo Seco;

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[725] The Jones Act requires shipping between US ports to be conducted with US-built, US-owned, and US-crewed vessels. The Jones Act has the practical impact of limiting the type of LNG vessels that can be used between US LNG export terminals and Puerto Rico. *See* 46 U.S.C. § 50102. Foreign ports are exempt from the Jones Act, which is why LNG imports to Puerto Rico are from Trinidad and Tobago.

[726] *See* Proposed IRP, page 7-2.

[727] *Id.* at page 7-2. Note that 6.5 MMtpa translates to approximately 312 billion cubic feet (bcf).

[728] *Id.* at page 7-5.

[729] *Id.* at page 7-6.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

- Additional regasification capacity and new natural gas pipelines, first from EcoEléctrica LNG Import Terminal to Aguirre and then to San Juan; and
- No new gas infrastructure.

559. In the Proposed IRP, PREPA did not consider the AOGP option.[730] PREPA also did not recommend the delivery of LNG or CNG to San Juan via container.[731] The Proposed IRP also did not consider new natural gas pipelines as a feasible option based on past public opposition to earlier pipeline proposals.[732] In addition, PREPA determined that alternative fuels: propane, ethane, and biofuels would not provide long-term alternatives to PREPA.[733]

560. PREPA narrowed its options to four specific forms of LNG infrastructure:[734]

- Land-based LNG at San Juan with pipeline to Palo Seco;
- Ship-based LNG at Mayagüez (West);
- Ship-based LNG at Yabucoa (East); and
- Ship-based LNG at San Juan (supply to San Juan only).

561. PREPA's estimates for fuel infrastructure costs for these four options are presented in Exhibit 7-5 of the Proposed IRP. These estimates ranged from $408 to $590 million for the land-based LNG at San Juan with a pipeline to Palo Seco; $167 to $222 million (each) for the Mayagüez/ Yabucoa/ San Juan ship-based LNG option.[735]

562. PREPA developed costs estimates for its proposed natural gas infrastructure investments from several sources. For the $492 million land-based LNG at San Juan and pipeline to Palo Seco, PREPA utilized the same value that it provided in the 2015 IRP and inflated that estimate to 2018 dollars.[736] PREPA did not attempt to update the values with other sources or comparative projects. PREPA's 4.2-mile pipeline estimate is based on a downward revision to the $65 million value from the 2015 IRP based on current construction costs and use of existing rights-of-way.[737]

563. In response to ROI 2-14, PREPA indicated that the base estimate of $185 million for the floating ship regasification unit (FSRU) costs associated with Yabucoa, Mayagüez, and

[730] *Id.* at page 7-8.

[731] *Id*. at page 7-13.

[732] *Id.* at page 7-14.

[733] *Id.* at page 7-15.

[734] *Id.* at page 7-17.

[735] *Id.* at page 7-18.

[736] Energy Bureau's ROI 2-13, July 18, 2019.

[737] *Id.*

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

San Juan was based on two studies (Oxford Institute of Energy Studies and Poten and Partners).

564. In response to ROI 2-21(i), PREPA provided low and high capital cost estimates for its fuel infrastructure options. The low case is 10% lower than the base case and the high case is 20% higher than the base case.[738] PREPA indicated that the low and high case were based on professional judgement and not attributable to any specific source.[739] In response to ROI 06-05, PREPA conducted an analysis utilizing higher infrastructure costs than its reference case based on discussion from the September 5, 2019 Technical Hearing.[740] PREPA's ROI response included new high cost values for the land-based LNG and ship-based LNG. These new high values were $650 million for the land-based LNG and $350 million for ship-based LNG.[741]

565. Under the S4S2S13B scenario provided in response to ROI 6-05 with the higher infrastructure costs, PREPA found that the Aurora model did not build any new CCGTs, extends EcoEléctrica's operations through 2035, and runs existing units at higher capacity factors.[742] The results from this scenario indicate that higher than expected natural gas infrastructure costs would result in material changes to future resource builds and operations and are informative to the risk of potential cost overruns for PREPA's proposed natural gas fuel infrastructure projects. A high-end $650 million land-based LNG capital costs shown in ROI 6-05 is a reasonable upper bound for this capital-intensive project. As Empire Gas witness Mr. González Simounet noted, PREPA has had a history of failed LNG import projects in the past, a history which supports using a higher capital cost to factor in uncertainty risk. As discussed in Part IV, the Energy Bureau **DOES NOT APPROVE,** PREPA's proposed gas infrastructure, since the Energy Bureau only authorized PREPA to begin preliminary work on new generation and/or energy storage at Palo Seco, subject to the constraints set forth in the Modified Action Plan.

G. Resource Plan Development Documentation and Analysis

566. Section 2.03(H)(1) and (2) of Regulation 9021 requires PREPA to document the development of its Resource Plans and sets forth a list of factors that PREPA must consider and tasks it must perform in creating the Resource Plan some of which we have highlighted. This must include a description of the mechanism and criteria used

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738 *Id*.

739 *Id.*

740 Energy Bureau's ROI-6, September 6, 2019.

741 *Id.* Exhibit 7-5 of the Proposed IRP had a high land-based LNG value of $590 million and a high ship-based LNG value of $222 million.

742 Energy Bureau's ROI-6, September 6, 2019.

to select a Preferred Resource Plan.[743] PREPA must provide a coherent table of resources, by year, including existing and new supply and demand resources needed to meet its peak load, inclusive of a PRM.[744] PREPA must show its annual "net position" relative to its needs.[745] For its Preferred Resource Plan, supplemental information on capacity contributions by resource, annual generation, emissions by resource, fuel consumption, and cost components must be included.[746]

567. Regulation 9021 also requires a Resource Plan Development Analysis, comprised of Capacity Expansion modeling and resource plan sensitivity analyses.[747] The analysis: must consider all resources (supply- and demand-side) and costs; shall comprehensively discuss any plans excluded from consideration;[748] and, each plan must meet renewable portfolio standards.[749] Sensitivity analyses must consider the uncertainty of forecast assumptions.[750] The purpose of the sensitivity analyses is to examine the robustness of resource plans, or how each plan would be affected by changed assumptions. Sensitivity analyses are intended to inform the selection of PREPA's Preferred Resource Plan[751].

568. PREPA must select a Preferred Resource Plan, using minimization of the present value of revenue requirement as the primary criterion. Other criteria can be considered, including the public interest. PREPA is required to discuss all factors that were considered when selecting its Preferred Resource Plan.[752]

1. PREPA Filing

569. As noted in Part III(D) of this Final Resolution and Order on Resource Needs Assessment, PREPA did not prepare a formal annual "net position" based on its existing resource base and load forecast. Nevertheless, PREPA provided enough information for the Energy Bureau to make that assessment.[753] PREPA provided in the Proposed IRP

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[743] *See* Regulation 9021 § 2.03 (H)(1)(a)(i).

[744] *Id*. at § 2.03 (H)(1)(a)(v).

[745] *Id*. at § 2.03 (H)(1)(b).

[746] *Id.*

[747] *Id*. at § 2.03 (H)(1)(a)(i).

[748] *Id*. at § 2.03 (H)(2)(a)(viii).

[749] *Id*. at § 2.03 (H)(2)(a)(ix).

[750] *Id*. at § 2.03 (H)(2)(b).

[751] *Id.*

[752] *Id*. at § 2.03 (H)(2)(d).

[753] Resource Needs Assessment (Part III(D)) of this Final Resolution and Order discusses PREPA's annual net position, the impact of battery storage capacity, and the need for new capacity resources.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

Exhibits abbreviated resource tables and figures[754] to meet peak load and a reserve margin[755] for its assessed Scenarios in the body of the Proposed IRP, and in more detail in the metrics files workpapers accompanying the Proposed IRP.[756]

a. Overview of PREPA resource plan documentation and development

570. PREPA's set of alternative resource plans are known as "Scenarios", developed using the LTCE module of Aurora's modeling tool.[757] PREPA's resource plan documentation and development is set out primarily in Part 8 of the Proposed IRP, "Resource Plan Development", along with extensive workpapers including detailed "metrics" files.[758] Metrics files contain the results of PREPA's analyses, complementing the material included in Part 8 of the full Proposed IRP document, and include the input parameters that were used for any given Scenario.[759]

571. PREPA's Proposed IRP contained analysis of thirty-five (35) resource plans, or 35 separate Scenarios, and the results were summarized in Exhibits 8-1, 8-2, and 8-3. The information in those exhibits, including new resource builds, resource retirements and a set of "Central Metrics",[760] is also identically provided in Part 1 of the Proposed IRP, "Introduction and Summary of Conclusions", as Exhibits 1-7, 1-8, and 1-9.

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754 *See* Proposed IRP, Part 8, Resource Plan Development, Exhibits 8-12, 8-13, 8-15, 8-16, 8-17, 8-28, 8-29, 8-31, and 8-32 (Scenario 4); 8-43, 8-44, 8-45, 8-46, and 8-47 (ESM Plan); 8-63, 8-64, 8-65, 8-66, and 8-67 (Scenario 1); 8-75, 8-76, 8-77, and 8-78 (Scenario 3); 8-86, 8-87, and 8-88 (Scenario 5).

755 The resource tables and figures provided included the total resources needed to meet PREPA's depiction of the required PRM, which for most assessed Scenarios was greater than the threshold PRM of thirty percent (30%) as described in the Resource Needs Assessment(Part III(D)) of this Final Resolution and Order.

756 The metrics files included tables on a power plant specific basis, which is more granular than the "by technology" summaries generally contained in the Proposed IRP Exhibits. The metric files also included unit-specific data representing the output data from the Aurora modeling, in the "resource year" tabs.

757 The PREPA Workpaper, "Aurora Methodology and Hourly Dispatch Considerations" describes the modeling tool.

758 Excel-based metrics files were provided for all Scenarios initially examined in the Proposed IRP. Subsequent responses to Requests of Information that included additional scenario or sensitivity runs also included metrics files of the same format.

759 Scenario definitions are provided by PREPA in its introductory chapter, Part 1 of the Proposed IRP. Each modeled Scenario has its own Excel-spreadsheet metrics file. The metrics files all have the same structure, e.g., the tab naming conventions are the same, and the type of content within each tab is the same.

760 "Central Metrics" presented by PREPA include the net present value of revenue requirements across the 2019-2038 period ("NPV @ 9% 2019-2038"), which is a summation of all operating, fuel, maintenance, and capital costs for each scenario, discounted with a nine percent (9%) nominal discount rate. The Central Metrics also include the average, real, first-10-year all-in cost per MWh ("Average 2019-2028 2018$/MWh"), the RPS percentage attained in 2028, the NPV of "Deemed Energy Not Served" (ENS), the summation of NPV+ENS, the lowest reserve margin reached, the percentage emissions reductions in 2038 (from 2019), and the total capital investment.

572. In addition to describing its proposed Preferred Resource Plan in detail in Part 8, a summary of that plan is also presented in Part 1.2 of the Proposed IRP, "Summary of Conclusions and Recommendations". The Preferred Resource Plan is presented as the ESM Plan,[761] with elements based in part on PREPA's Scenario S4S2 and in part based on "fixed decisions".[762]

573. An additional fifty-two (52) sets of modeling results are also presented by PREPA, Forty-six (46) and six of which are in response to the Energy Bureau and AES-PR's ROIs[763] respectively, giving rise to a total of eighty-seven (87) resource Scenario results presented in the Proposed IRP.[764] The additional sets of ROIs from other intervenors, while extensive,[765] did not directly result in PREPA's preparation of any new Scenarios. The additional fifty-two (52) modeling runs were requested, and responses provided by PREPA, in order to supplement the thirty-five (35) Scenarios presented in the original filing with resource plans that utilized different underlying assumptions, described as follows:

- <u>Energy Bureau's ROI-6-2, renewable cost sensitivities</u>.[766] The responses to this ROI contain two base renewable cost sensitivities (sensitivity 8) to high and low load cases; and three high renewable cost sensitivities (sensitivity 6) to base, high and low load cases (respectively, the five Scenarios are S3S2S8H, S3S2S8L, S3S2S6B, S3S2S6H, and S3S2S6L).
- <u>Energy Bureau's ROI-6-3, carbon adder Scenarios</u>.[767] Three Scenarios were run that included the effect of a carbon price adder (defined as sensitivity

[761] *See* Proposed IRP, page 1-7: "Taking all these factors into consideration, Siemens recommends that PREPA proceed with the execution of the ESM Plan with reassessment of the ESM assumptions and project progress in two to three years' time – near the completion of recommended development and permitting activities". *See* Proposed IRP, page 10-2: "The ESM plan was selected as the recommended plan since it represents a low cost, practical option that provides the high level of renewable energy contribution and significantly improves the resiliency of the system."

[762] *See* Proposed IRP, page 8-44: "The Energy System Modernization Plan (ESM) is a derivative of Scenario 4 based on fixed generation expansion additions discussed below and detailed in the work paper "Considerations on the ESM Plan".

[763] Energy Bureau's ROI 6, September 6, 2019 (6-2, 6-3, 6-4, 6-5, 6-6); Energy Bureau's ROI 7, September 12, 2019 (7-1, 7-2, 7-3); Energy Bureau's ROI 9, October 29, 2019 (9-1, 9-3); Energy Bureau's ROI 10, December 13, 2109 (10-5); and AES-PR ROI 1, October 2, 2019 (1-1 and 1-2).

[764] PREPA also conducted additional modeling runs as part of its response to Energy Bureau's ROI 7-6, September 12, 2019; PREPA responded in parts on September 27 and October 4, 2019. The modeling runs illustrate peaking plant build-out sensitivity under different assumptions for the ESM, S4S2B, and S3S2B scenario but no NPV results were requested or provided for those runs.

[765] A total of twenty (20) sets of ROIs to PREPA, comprising 396 questions, were made by intervenors, inclusive of AES-PR's modeling requests.

[766] Energy Bureau's ROI 6, September 6, 2019; PREPA responded in parts September 27, October 4, October 15, and October 18, 2019.

[767] *Id.*

10) on resource buildouts for Scenarios S4S2, S3S2, and ESM (S4S2S10B, S3S2S10B, ESMS10).

- Energy Bureau's ROI-6-4, delayed solar PV installation.[768] This Scenario assumes a delay in the build out of solar PV and storage resources in S3S2B, defined as sensitivity 11 (S3S2S11).
- Energy Bureau's ROI-6-5 and ROI-6-6, high and low LNG infrastructure cost (north) sensitivities. These sensitivities, labeled as sensitivity 12 (low infrastructure costs) and sensitivity 13 (high infrastructure costs) ran two modeling scenarios (for S4S2B and ESM Base) for each of a "high" and "low" LNG infrastructure cost assumption (S4S2S12B, S4S2S13, ESMS12 Base, ESMS1 Base).
- Energy Bureau's ROI-7-1, ESM with actual San Juan 5&6 gas pricing.[769] This Scenario is the ESM case re-run with actual New Fortress Energy pricing for the San Juan 5&6 converted units. This case was requested to ensure accurate information concerning the actual costs of operation of the San Juan 5&6 conversion.
- Energy Bureau's ROI-7-2, unconstrained BESS and solar PV limitations in the model, from 2022 onward (inclusive of 2022).[770] These two Scenarios allow for a greater pace of solar PV and battery storage installation than is used for other Scenarios. Post-2021, there are no limitations placed on the amount of annual solar PV or battery storage that can be installed. These are run for S4S2B and S3S2B.
- Energy Bureau's ROI-7-3, new modeling runs for S4S1H and S4S1L.[771] These Scenarios allow a comprehensive treatment of S4S1 across both high and low load Scenarios.
- Energy Bureau's ROI-7-6, peaker resource build rationale for S4S2B, S3S2B, and ESM.[772] Siemens conducted additional runs to assess LTCE results absent the fixed decisions and found the model to build more peaking resources in total over time. This result is an artifact of the 80% local resource requirement in Strategy 2. No NPV results were presented for these modeling runs, as the Requirement of Information pertained only to determining if resource builds were the results of fixed decisions or economic model-based capacity expansions.

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768 *Id.*

769 Energy Bureau's ROI 7, September 12, 2019; PREPA responded in parts on September 27 and October 4, 2019.

770 *Id.*

771 *Id.*

772 *Id.*

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

- Energy Bureau's ROI-8-1, energy not served computation correction.[773] A correction to the energy not served computations was made for the S3S2B run to account for a modeling error related to how the San Juan units 5 and 6 (converted) were accounted for.

- Energy Bureau's ROI-9-1, requested revised LTCE modeling runs for Modified baseload forecast incorporating No EE and Low EE.[774] No energy efficiency (No EE) reflects use of PREPA's baseload forecast with no adjustments for EE savings. Low energy efficiency (Low EE) reflects use of a small amount of EE adjustments applied to the baseload forecast.

- Energy Bureau's ROI-9-3, requesting corrections to the metrics files associated with S3S2S8, S4S2, and S3S2.[775] Corrections were required to address sensitivity 8 cost adjustments, operation and maintenance cost adjustments, and wind resource fixed cost adjustments.

- Energy Bureau's ROI-10-5, EcoEléctrica new PPOA comprehensive input assumptions, for baseload levels with varying amounts of EE.[776] These ROIs requested revised LTCE modeling runs with the full attributes (capacity cost payment reductions and increases in gas prices) of the revised EcoEléctrica PPOA, across all major Scenario categories and for three different load levels. Fourteen new modeling runs were executed under baseload (S3S2, S4S2), low EE (S4S2B, S1S2B, S3S2B, S5S1B), no EE (S4S2B, S1S2B, S3S2B, S5S1B), low EE with no limitations on solar PV and battery storage buildout post-2021 (S4S2 no solar limits, S3S2 no solar limits), and no EE with no limitations on solar PV and battery storage buildout post-2021 (S4S2 no solar limits, S3S2 no solar limits).

- AES-PR's ROI-1-1 and ROI-1-2, AES plant gas conversion and retirement Scenarios.[777] In those ROIs, PREPA modeled alternative NPV outcomes under different AES gas conversion or retirement assumptions and using different load forecasts.

574. A summary listing of the full set of 87 Scenario modeling results is presented in Appendix C to this Final Resolution and Order, "Summary of Resource Development Scenarios". It shows the net present value (NPV) of revenue requirements for each

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[773] Energy Bureau's ROI 8, October 5, 2019.

[774] Energy Bureau's ROI 9, October 29, 2019.

[775] *Id.*

[776] Energy Bureau's ROI 10, October 29, 2019.

[777] AES-PR's ROI, October 2, 2019.

Scenario, along with other metrics. Appendix C also contains tables of capacity additions and retirements, for key sets[778] of Scenarios.

575. Additionally, during the Evidentiary Hearing, PREPA confirmed the direction of the Scenario valuation effect that an application of carbon pricing would have on the modeling results. The effect, which can be considered as an "adder" to the overall NPV of any given Scenario if carbon pricing were directly considered, would be in proportion to the carbon price, and in proportion to the aggregate carbon emissions (arising from the Scenario's portfolio of emitting resource types) for any given Scenario.[779] Section 1.9(3)(H) of Act 17 states that the integrated resource plan shall include, but not be limited to PREPA's environmental impact assessments related to air emissions and water consumption, solid waste, and other factors such as climate change. The effect of carbon emissions directly impacts climate change, and any reductions in carbon emissions support efforts to mitigate climate change.

576. Other than the Scenarios produced in response to Energy Bureau's ROI-6-3, no direct costs or price effects from carbon dioxide emissions are included in the Proposed IRP results for PREPA's Preferred Resource Plan, or the Modified Preferred Resource Plan, or the summary compiled in Appendix C of this Resolution and Order. However, PREPA's testimony at hearing establishes an important benchmark for estimation of ascertaining the relative directional impact of Scenario S3S2, compared to the ESM and S4S2B Scenarios, since the ESM and S4S2B Scenarios exhibit greater carbon emissions than Scenario S3S2.[780]

577. PREPA confirmed that all else equal, a scenario with higher carbon emissions would be costlier than a scenario with lower carbon emissions, if a carbon price or carbon adder was considered.[781]

b. PREPA scenario summary modeling results

578. PREPA's original modeling results for the Net Present Value of Revenue Requirements (NPVRR or NPV) for the original thirty-five (35) filed Scenarios are presented in the Proposed IRP's Exhibit 8-3 in tabular form, and graphically in Exhibits 8-4, 8-5 and 8-

[778] The key set of scenarios especially reflect PREPA's most up-to-date modeling incorporating the comprehensive input assumption set for the new PPOA for EcoEléctrica and incorporating assessment of the effect of different levels of energy efficiency on the baseload forecast.

[779] Evidentiary Hearing, February 6, 2020, morning session, 01:28:00.

[780] The ESM (Base) Scenario emits a total of 75.12 million tons of CO_2 over the 2019-2038 period. The S3S2B Scenario emits a total of 61.12 million tons of CO_2 over the same period. The S4S2B Scenario emits 63.6 million tons of CO_2 over that period. PREPA metrics files, ESM (base), S4S2B, S3S2B; "Emissions" tab, at row 13, columns W through AP.

[781] Evidentiary Hearing, February 6, 2020, morning session, 01:25:00 to 01:3032:00.

6. Exhibits 8-1 and 8-2 show the new resource builds and retirement decisions for those Scenarios.

579. Eighteen (18) of those Scenarios utilize standard assumptions for resource costs, fuel prices, and resource and fuel availability in Puerto Rico, across three different forecast load levels- base, high and low. All three load levels each include "full EE".[782] Those NPV results are shown in Table 7 below and are ordered from lowest to highest NPV within each of the base, high and low load groupings.[783]

[782] "Full EE" reflects a total reduction in load by 2038 of thirty percent (30%) from what it otherwise would have been.

[783] NPVRR cost comparisons are most useful when using the same load level.

Table 7. Scenario NPVRR Results - Base, High, and Low Load

Scenario	NPVRR (2018 $000)	NPV ($ millions) Change from Lowest Cost within Load Group	% Change from Lowest Cost within Load Group
Base Load			
S3S2B	$13,843,500		0.0%
S4S1B	$14,028,437	$185	1.3%
S5S1B	$14,111,652	$268	1.9%
S4S2B	$14,339,167	$496	3.6%
S1S1B	$14,355,763	$512	3.7%
S4S3B	$14,405,252	$562	4.1%
ESM Base	$14,420,218	$577	4.2%
S3S3B	$14,538,746	$695	5.0%
S1S3B	$14,687,535	$844	6.1%
S1S2B	$14,773,629	$930	6.7%
High Load			
S4S2H	$15,143,866		0.0%
ESM High	$15,243,860	$100	0.7%
S3S2H	$15,291,789	$148	1.0%
S1S2H	$16,123,599	$980	6.5%
Low Load			
S4S2L	$12,854,423		0.0%
S3S2L	$13,353,915	$499	3.9%
S1S2L	$13,524,539	$670	5.2%
ESM Low	$13,941,335	$1,087	8.5%

Source: PREPA, Exhibit 8-3 and accompanying metrics files. Synapse ordering and computation of percentage change. Note: NPVRR values contained in the metrics files workpapers were used if those values differed from the values listed in Exhibit 8-3.

580. The remaining seventeen (17) scenarios, from the original thirty-five (35) scenarios which reflect sensitivities to resource costs, fuel prices, and resource and fuel availability all reflect a baseload forecast. Those NPV results are shown in Table 8, and where applicable are also ordered from least-cost to highest cost within each grouping.

Table 8. Sensitivities NPVRR Results – Base Load

Scenario	Net Present Value Revenue Requirements (2018 $000)	NPV ($ millions) Change from Lowest Cost within Load Group	Percentage Increase of NPVRR from Lowest Scenario
High Gas Price			
S3S2S5B	$14,811,928		0.0%
S4S2S5B	$15,244,467	$433	2.9%
S1S2S5B	$15,378,227	$566	3.8%
ESMS5B	$15,601,077	$789	5.3%
S5S1S5B	$15,649,330	$837	5.7%
No Ship-LNG in SJ			
S1S2S7B	$15,685,669		
Only Ship-LNG in SJ			
S4S2S4B	$14,637,908		
EcoEléctrica instead of CC at Costa Sur			
S4S2S9B	$14,469,338		
Low Cost PV/Batteries			
S5S1S1B	$13,802,131		0.0%
S4S2S1B	$14,001,068	$199	1.4%
ESMS1B	$14,110,248	$308	2.2%
S1S2S1B	$14,449,784	$648	4.7%
Normal Cost PV/Batteries			
S3S2S8B	$14,357,561		
S3S2S8B – corrected ROI-9-3	$14,823,560		
High Cost PV / Batteries			
S5S1S6B	$15,324,562		0.0%
S4S2S6B	$15,554,080	$230	1.5%
ESMS6B	$15,581,039	$256	1.7%
S1S2S6B	$16,018,738	$694	4.5%

Source: PREPA, Exhibit 8-3 and accompanying metrics files. Synapse ordering and computation of percentage change. Note: NPVRR values contained in the metrics files workpapers were used if those values differed from the values listed in Exhibit 8-3.

581. Additional scenarios to reflect baseload forecast levels but with different amounts of EE – known as Low EE and No EE scenarios – were modeled in response to the Energy

Bureau's ROI-9-1 and ROI-10-5[784]. The modeling results from the responses to these ROIs also contain full representation of the new EcoEléctrica PPOA[785] contractual costs for that facility, and thus denote a critically important set of updates to the core modeling processes, which did not include such costs comprehensively.[786] PREPA specifically notes in its responses to ROI-9-1 and ROI-10-5 that the modeling assumptions incorporate the "most likely contractual conditions for EcoEléctrica"[787] and considers, " the most up to date information on the PREPA's system and thus making the results presented here representative of future conditions as seen at this moment in time".[788]

582. Those results are presented in Table 9 and Table 10 below. Modeling results in response to Energy Bureau's ROI-10-5 presented in Table 10 below use the "Eco PPOA with Storage Refined (Final)**" values, as described in the response and reflective of "results with the new PPOA for all cases with battery storage refined, as applicable depending on the case".[789]

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[784] Energy Bureau's ROI 9, October 29, 2019; Energy Bureau's ROI 10, December 13, 2019.

[785] Resolution and Order, Case No. NEPR-AP-2019-0001, In Re: Request for Approval of Amended and Restated Power Purchase and Operating Agreement with EcoEléctrica and Natural Gas Sale and Purchase Agreement with Naturgy, March 11, 2020.

[786] Original core modeling included a reduction in capacity costs for the EcoEléctrica facility for most Scenarios but did not include the increased gas commodity costs, for 2020 forward, associated with the new PPOA. *See* fuel price in Table 5 below.

[787] Energy Bureau's ROI 9; Siemens November 13, 2019 Memo, "ROI 9 Assumptions for Modeling".

[788] Energy Bureau's ROI-10-5, Section 2 "Modeling Assumptions", December 13, 2019, page 8.

[789] *Id.* at page 9.

Table 9. Energy Bureau's ROI-9-1 NPVRR Results–Low and No Energy Efficiency Adjustments to Baseload

Scenario	Net Present Value Revenue Requirements (2018 $000)	NPV ($ millions) Change from Lowest Cost within Load Group	% Change from Lowest Cost within Applicable Group
Base Load - Low Energy Efficiency			
S3S2	$16,009,904		0.0%
ESM	$16,393,013	$383	2.4%
S4S2	$16,555,636	$546	3.4%
S5S1	$16,585,288	$575	3.6%
S1S2	$17,176,251	$1,166	7.3%
Base Load - No Energy Efficiency			
S3S2	$16,495,437		0.0%
ESM	$17,328,147	$833	5.0%
S4S2	$17,633,201	$1,138	6.9%
S5S1	$17,676,430	$1,181	7.2%
S1S2	$18,120,500	$1,625	9.9%

Source: NPVRR values directly from PREPA revised response to Energy Bureau's ROI-9-1, Table 2: Main Metrics Results for All Scenarios, March 2, 2020. Note: Percentage differences from lowest cost Scenario within each load level grouping computed by Synapse.

Table 10. Energy Bureau-PREPA ROI-10-5 NPVRR Results – Full, Low and No Energy Efficiency

Scenario	NPVRR ($2018 000)	NPV ($ millions) Change from Lowest Cost within Load Group	% Change from Lowest Cost within Applicable Group
Base Load - Full Energy Efficiency			
S3S2B	14,144,101		0.0%
S4S2B	14,824,335	680	4.8%
Base Load - Low Energy Efficiency			
S3S2B Low EE	15,978,394		0.0%
S4S2B Low EE	16,679,347	701	4.4%
S5S1B Low EE	16,736,222	758	4.7%
S1S2B Low EE	17,464,845	1,486	9.3%
Base Load - Low Energy Efficiency, No Solar Limits			
S3S2B Low EE, No Solar Limits	16,124,669		0.0%
S4S2B Low EE, No Solar limits	17,283,426	1,159	7.2%
Base Load - No Energy Efficiency			
S3S2B No EE	16,741,505		0.0%
S5S1B No EE	17,463,626	722	4.3%
S4S2B No EE	17,739,315	998	6.0%
S1S2B No EE	18,805,782	2,064	12.3%
Base Load - No Energy Efficiency, No Solar Limits			
S3S2B No EE, No Solar Limits	16,961,018		0.0%
S4S2B No EE, No Solar limits	18,552,371	1,591	9.4%

Source: PREPA Supplemental corrected response to Energy Bureau's ROI-10-5 a), b), and c). NPVRR value is from column "Eco PPOA with Storage Refined (Final)**". January 22, 2020. Note: Percentage differences from lowest cost Scenario within each load level grouping computed by Synapse.

583. PREPA discusses the modeling results in a number of sections of the Proposed IRP.[790] In each section of the Proposed IRP, to varying extents, PREPA describes the Scenario results for major metrics, including the level of capacity additions and retirements, capital expenditures, the future resource mix and fuel diversity of the scenario, how the scenario meets RPS requirements, the system costs for the Scenario, resiliency considerations (presenting the value of PREPA's computation of energy deemed not served),[791] sensitivity analysis results, and nodal analysis results.

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[790] *See* Proposed IRP, Section 8.2 for Scenario 4; Section 8.3 for the ESM Plan; Section 8.4 for Scenario 1; Section 8.5 for Scenario 3; and, Section 8.6 for Scenario 5.

[791] This is addressed in Transmission and Distribution System (Part III(I)) of this Final Resolution and Order.

584. The fuel prices for the EcoEléctrica facility were different in the original IRP filing, compared to the fuel prices used for EcoEléctrica in the modeling done in response to Energy Bureau's ROI-9-1 and ROI-10-5, both of which specifically reflect the new PPOA commodity pricing for gas.[792] Because of that change to the input assumption, results from the Proposed IRP modeling runs should not be directly compared to results from the ROI-9-1 and ROI-10-5 modeling runs as part of a differential cost analysis, although comparisons across the Scenarios within the Proposed IRP filing modeling, or across the Scenarios within each of the responses to ROI-9-1 and ROI-10-5 are valid for such purpose. Table 11 below shows the fuel costs for the EcoEléctrica facility as represented in the Proposed IRP, and as modeled comprehensively to reflect the new PPOA terms.

Table 11. Fuel Price for EcoEléctrica, nominal $/MMBTU, Original Contract and New PPOA Scenarios

Source:	Proposed IRP Filing	Response to Energy Bureau-PREPA ROI-10-5, Attachment 1
Year	EcoEléctrica Original Contract Fuel Price, $/MMBTU	EcoEléctrica New PPOA Fuel Price, $/MMBTU
2020	4.96	8.74
2021	5.06	9.16
2022	8.10	9.26
2023	8.37	9.52
2024	8.67	9.82
2025	8.93	10.08
2026	9.14	10.29
2027	9.23	10.38
2028	9.34	10.49
2029	9.39	10.54
2030	9.59	10.74
2031	9.65	10.80
2032	9.90	11.05

Source: PREPA Metrics Files, "resource year" tab, S4S2B (original) and S4S2 (response to Energy Bureau Requirement of Information, January 22, 2020, 10-5. All fuel prices for EcoEléctrica (original contract), EcoEléctrica under the new PPOA terms ("EcoEléctrica New PPOA"), and other new gas combined cycle resources used in the modeling runs are directly available in the "resource year" tab of the metric file for any given Scenario, as "Fuel Cost", in units of $/MMBTU, per PREPA's response to Energy Bureau's ROI-10-5 (f). Note: Fuel price shown for original filing was for both the EcoEléctrica location (through 2024) and the Costa Sur new combined cycle unit location (2025-2032).

[792] Response to Energy Bureau's ROI-9-1 and ROI-10-5.

c. Capacity additions and retirements – initial IRP and subsequent ROI-6 and ROI-7 set modeling

585. PREPA provided capacity additions and retirements associated with each of the originally filed thirty-five (35) Scenarios within the body of the Proposed IRP, in response to Requirements of Information, and in all metrics files. The Tables included in Appendix C of this Final Resolution and Order contain the specific listing of capacity additions by 2025 and by 2038 for all Scenarios. The additions and retirements seen across the originally-filed Scenarios and those Scenarios modeled in response to the Energy Bureau's Sixth and Seventh ROIs are summarized as follows:

- <u>Renewable Additions – Solar PV</u>.[793] All Scenarios met or exceeded renewable portfolio standard requirements through the addition of solar PV resources, with all but one, the ESM low load scenario, containing at least 2,100 MW of new solar PV by 2025. The ESM baseload scenario contained 2,400 MW by 2025; S4S2B contains 2,220 MW by 2025; and S3S2B builds 2,820 MW of solar PV by 2025. Notably, increases in solar PV after 2025, through to the end of the planning horizon in 2038 are relatively modest for the ESM baseload (2,580 MW total), S4S2B (2,820 MW total) and Scenarios 1 and 5 (generally well under 3,000 MW total); while Scenario 3 solar builds are generally at or above 4,000 MW by 2038.[794]
- <u>Battery Storage Additions.</u> All Scenarios included extensive, economically-driven buildouts of battery energy storage under the LTCE modeling.[795] PREPA's ESM Scenario limited the build out to 920 MW by 2025, whereas S4S2B and S3S2B saw 1,320 MW of battery storage by 2025. Scenarios 1 and 5 saw lower buildout, to 1,280 and 1,200 MW, respectively, by 2025. The ESM and S4S2B Scenarios both saw 1,640 MW of battery storage by 2038, lower than S3S2B battery buildout of 3,040 MW.
- <u>Renewable Additions – Other</u>. No other renewable additions resulted from the modeling runs. PREPA noted that low cost onshore wind assumptions

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[793] In addition to solar PV builds resulting from the modeling, PREPA includes in all Scenarios a fixed amount of distributed solar PV that totals just over 1,000 MW by 2028. *See* Proposed IRP, Appendix 4: Demand Side Resources, Exhibit 3-10.

[794]Energy Bureau's ROI 7, September 12, 2019; PREPA responded in parts on September 27 and October 4, 2019, 7-3(a), Attachment 1. PREPA's updated compilation of Scenario results, building upon an originally provided workpaper assembling thirty-five (35) Scenario results containing the solar PV build out levels by 2025 and by 2038 for fifty (50) Scenarios inclusive of the original 35 Scenarios plus an additional fifteen (15) Scenarios produced in response to ROIs. *See* posted filename, "PREPA ROI_6 and 7 Attachment Summary PREPA IRP+ROI.xls".

[795] All modeled battery storage builds could be provided by either utility-scale or distributed battery systems, and smaller-scale systems such as those provided by VPPs, which represent an acceptable choice for reliability reasons, as long as PREPA visibility and/or control is ensured. Evidentiary Hearing, February 6, 2020, morning session, 02:26:00 to 02:32:00.

lead to wind levelized costs approaching, but still exceeding levelized solar costs by 2038.[796] PREPA also did not include any capacity benefit that might be associated with wind output during peak hours in its modeling.[797] PREPA notes in the Proposed IRP that a preliminary offshore wind study[798] identified potential locations, but that costs are higher than solar PV or onshore wind resources; the study concluded future viability for Puerto Rico if cost reductions are seen.[799]

- Non-Renewable Additions. Peaking capacity to replace existing Frame 5 units.[800] All Scenario plans include varying levels of "replacement"[801] peaker builds (325 MW to 507 MW).[802] The ESM includes 421 MW; S4S2B includes 371 MW; and S3S2 includes 348 MW. All of the peaking resource builds for ESM, S4S2B, and S3S2B are "fixed decision" builds.[803]
- Non-Renewable Additions -Mayagüez peaker conversion.[804] None of the Scenarios included as an economic build, the conversion of the four Mayagüez oil-fired peaking units to dual-fuel status, despite PREPA's suggestion as part of its ESM Plan that "costs associated with supplying natural gas would be returned quickly through the associated reduction in fuel supply cost of natural gas relative to diesel fuel".[805] The ESM plan includes such conversion as a fixed decision.
- Non-Renewable Additions – combined cycle capacity associated with the natural-gas converted San Juan units 5 & 6. All Scenarios included as a fixed

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[796] *See* Proposed IRP, Exhibit 6-43, page 6-35.

[797] All Scenarios, PREPA metrics files, "resource year" tab: the "peak capacity credit" field for existing wind resources is zero. To the extent that future analysis is conducted with updated wind resource costs and/or performance characteristics, for onshore or offshore wind resources, it would be expected that this parameter would reflect actual capacity credit associated with even minimal levels of evening (i.e., peak period) wind output.

[798] *See* Proposed IRP, page 6-42, footnote 42, Rodríguez, Hector M., et al., "Preliminary Cost Assessment for Offshore Wind Energy in Puerto Rico", July 2015.

[799] *See* Proposed IRP, page 6-42.

[800] Energy Bureau's ROI-9-2, October 29, 2019. Response provided on November 27, 2019. PREPA describes the condition and status of its existing Frame 5 peaking units – also referred to as "old GTs" in the metrics files.

[801] PREPA's Workpaper, "Considerations on the ESM Plan" filed June 7, 2019, on the rationale behind the ESM Plan includes at page 2 a description of an unsolicited proposal received by the P3 Authority for replacement of PREPA's 18 Frame 5 gas turbine units.

[802] Energy Bureau's ROI 7, September 12, 2019; PREPA responded in parts on September 27 and October 4, 2019. Response ROI-7-3 (a), Attachment 1.

[803] *Id.* at Response 7-6 (a), (b) and (c).

[804] *See* Proposed IRP, page 7-12. PREPA describes a ship-based LNG source at Mayagüez to allow for natural gas fuel at the existing peaking facilities (four 50 MW simple cycle turbine units) at an estimated capital cost of $185 million and annual operating expenses of $9.6 million.

[805] PREPA's Workpaper, "Considerations on the ESM Plan" filed June 7, 2019, page 3.

input assumption[806] the combined cycle capacity of the converted San Juan units 5 & 6, except for one sensitivity (S1S2S7B) that excluded the new resource.

- Non-Renewable Additions – other combined cycle capacity excluding Palo Seco location. Almost all Scenarios included as a capacity expansion option a new combined cycle unit at Costa Sur to replace EcoEléctrica, or retention of the EcoEléctrica existing facility.[807] With very limited exception, no Scenarios included a model result with an economic build out of a new combined cycle facility at either Yabucoa or Mayagüez.[808] The ESM Scenario includes a new F-class combined cycle facility at Yabucoa in 2025, but this is a fixed decision made by PREPA for that Scenario.[809]

- Non-Renewable Additions – combined cycle at Palo Seco. Scenarios S4S2B and S4S2H build a new combined cycle at Palo Seco, as does the ESM Plan as a fixed decision, for all load levels. Scenario 5 does not build at Palo Seco but does instead build larger 369 MW combined cycle units at Costa Sur, one each in years 2025 and 2028. Scenario 1 does not build a new combined cycle unit at Palo Seco, by design based on the Scenario definition.[810] Scenario 3 generally does not build a new combined cycle at Palo Seco, except under sensitivity analyses which tested whether or not a build would occur with higher solar PV and battery costs.[811]

- Retirements.[812] All Scenarios retire the older steam units at Palo Seco, Aguirre, and San Juan during the timeframe 2019-2025, with most of those retirements occurring earlier, based on the model's incorporation of solar PV and battery storage, and peaking capacity, during the first five (5) years of the planning horizon. All Scenarios generally retire the Costa Sur units

[806] Resolution and Order, In Re: Request for Proposals for the Conversion of San Juan Units 5 and 6 to Natural Gas, Case No. CEPR-AI-2018-0001, October 4, 2018.

[807] The only exceptions were S3S2L (the lowest load level, and the fastest installation pace for solar PV and batteries) which retained EcoEléctrica through 2024; and S4S1B and S4S1L (both of which built an F-class combined cycle at Mayagüez instead).

[808] S4S1B and S4S1L both built an F-class combined cycle at Mayagüez in 2025, but neither of those Scenarios retained the EcoEléctrica facility (retired in 2024 in those scenarios) or built a new combined cycle unit at Costa Sur.

[809] PREPA explains its "fixed decisions" in its filed workpaper on its ESM Plan. That workpaper describes the nature and reasoning behind the four major groups of "fixed decisions" or included resources in PREPA's ESM Plan that were not selected by the LTCE model.

[810] Scenario 1 is designed as a "no new gas" Scenario. *See* Proposed IRP, page 5-4.

[811] Energy Bureau's ROI-6-2, September 6, 2019.

[812] Response to Energy Bureau's ROI-7-3 (a) Attachment 1, September 12, 2019. This contains all the retirement information in detail in an updated summary sheet.

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5&6 over the first few years of the horizon, with a few exceptions.[813] All Scenarios retire the AES units at the end of 2027. The Aguirre combined cycle units are retired earlier in Scenario 1 and 3, and are retained for longer periods in Scenario 4, 5, and the ESM Scenario. The converted San Juan units 5 and 6 are generally retained until the 2030s, although both the ESM Plan and Scenario 5 see an earlier economic retirement of Unit 6, in 2025 or 2026. Generally, EcoEléctrica is retired only in Scenarios where a new F-class combined cycle is built at Costa Sur, or in the few Scenarios where a new CC is built at Mayagüez (S4S1L, S4S1L).

586. As noted by PREPA, one of the main differences among Scenario 3, Scenario 4 and the ESM Scenario is whether, or not, a new combined cycle unit is built at Palo Seco. Scenario 3's assumed faster installation pace and lower costs for solar PV and battery storage renders the Palo Seco CC build uneconomic, and also results in higher solar PV builds in the post-2025 timeframe.[814]

d. Capacity additions and retirements – modeling in response to Energy Bureau's ROI-9-1

587. PREPA provided capacity additions and retirements information associated with each of the ten Scenarios (seen in Table 9, above) in the response to Energy Bureau's Ninth Requirement of Information. This ROI requested modeling runs with lower levels of EE than the original baseload forecast (which contained "full EE"). Appendix C tables contain the capacity addition and retirement results, which indicate the following:

- All Scenarios show increased levels of solar PV and battery energy storage for both 2025 and 2038, the end of the planning horizon. PREPA emphasizes that the results indicate a need to maximize the rate of solar PV adoption in the first five (5) years of the plan.[815]
- All Scenarios include retention of the EcoEléctrica unit under its new PPOA, at 530 MW. All Scenarios include the San Juan 5 & 6 combined cycle units converted to natural gas fuel. All Scenarios contain customer owned generation, primarily solar PV, as a fixed assumption in the modeling inputs and reaching 1,176 MW by 2038.[816] All Scenarios have the AES coal fired units retiring at the end of 2027

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[813] One or both units are retained longer in some of the Scenario 1 runs. Scenario 4 retains one unit longer under a high load scenario, and under a sensitivity where a combined cycle unit at Palo Seco is not built.

[814] Response to Energy Bureau's ROI-1-54 (a), August 8, 2019.

[815] PREPA's Response to Energy Bureau's ROI-9-1, December 6, 2019, pages 11 and 15.

[816] *See* metrics files, "metrics detail" tab, under solar customer owned and CHP. Customer-owned solar PV reaches 1,014 MW by 2038, and CHP resources reach 162 MW in all Scenarios.

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JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

- No new combined cycle unit at Palo Seco is selected under Scenario 3, for both No EE and Low EE load scenarios.
- A new 369 MW natural gas fired combined cycle unit at Palo Seco is selected by the model in the S4S2 Scenario, for both the No EE and the Low EE load levels, in 2028 (following retirement of the AES units).[817]
- The response to the ROIs shows no economic selection of a new combined cycle unit at Yabucoa in any of the Scenarios for which an LTCE was run. Similarly, no economic selection was made for any peaker conversions at Mayagüez. New 302 MW combined cycle units in 2025 at Palo Seco and Yabucoa are based on "fixed decisions" only for both the Low EE and No EE ESM Scenarios.[818]
- Scenario 1 has no new builds of combined cycle units, at Palo Seco or any other location, by scenario design. Scenario 5 has no new combined cycle builds at Palo Seco or Yabucoa but does build a 369 MW unit at Costa Sur in 2028.
- Fossil-fueled capacity retirements are similar in pace and quantity to the original modeling, with some variance in the exact date of retirements (due to increased load levels for No EE and Low EE scenarios). The tables in Appendix C list these retirements.

e. Capacity additions and retirements – modeling in response to Energy Bureau's ROI-10-5

588. The tables included in Appendix C to this Final Resolution and Order present PREPA's aggregate results on capacity additions and retirements arising from the modeling runs executed as part of PREPA's response to Energy Bureau's ROI-10-5. Those modeling runs fully incorporated the effect of the new PPOA contract terms for the EcoEléctrica facility, and also contained a "refinement" to the battery storage levels (seen in the Aurora modeling) to account for excessive solar PV curtailment that would otherwise occur in some modeling runs.[819] Energy Bureau's ROI-10 also requested modeling runs reflecting no limitations on the level of solar PV and battery energy storage build that the model could allow after 2021, and included modeling runs with the original baseload (Full EE), incorporating the new EcoEléctrica PPOA contract terms and refinements to battery storage levels as was done in the other runs in this response. The results are broadly similar to the results seen in response to the Energy Bureau's ROI-9.

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[817] PREPA's Response to Energy Bureau's ROI-9-1, metric files attachments, "Additions & Retirements" tab, October 29, 2019.

[818] PREPA's Response to Energy Bureau's ROI-9, at Table 3 (page 12), December 6, 2019.

[819] PREPA's Response to Energy Bureau's ROI-10-5, December 13, 2019, 10-5, page 10-11.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

589. For the S4S2B Full EE Scenario, a 302 MW CC is selected for installation by 2025 in the north, at the Palo Seco site.

f. PREPA Preferred Resource Plan

590. PREPA presents its overall recommendations and describes individual resource elements in Sections 1.2.1 and 1.2.2; and included its "Additions to Preserve Options and Hedge Uncertainties" in its Section 1.2.3. Additional information is also provided in Part 10 of the Proposed IRP, the Action Plan. These sections include the following recommendations, which in combination make up PREPA's original Preferred Resource Plan:[820]

Table 12. PREPA Recommended Elements of its Preferred Plan (ESM)

Element	Quantity/Time Frame	Description/Comment
MiniGrids - transmission	8 MiniGrids. Roughly 66% of infrastructure installed in first three years.[821]	$5.9 billion for 115 kV and 38 kV transmission system elements. Plus $2 Billion for other non-MiniGrid transmission elements. Operate in grid-isolated mode. No optimization analyses.[822]
Distribution hardening	Entire distribution system. Through 2026.	Feeder mainline undergrounding and substation upgrades to gas-insulated substations.[823]
Solar PV	1,380 MW/1st 4 years (end of 2022). RFPs for 250 MW blocks. 2,400 MW by end of 2025. Scenario-dependent.[824]	Limited by PREPA current approval and procurement programs. Notes urgency of "adding as much PV as practical".[825] Notes expiry of Federal tax credit.
Battery Energy Storage	920 MW of battery storage, first 4 years.[826]	
New Gas Turbines	18, 23 MW new GTs. Containerized NG fuel.	Fixed Decision.

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[820] *See* Proposed IRP, Section 8.3, page 8-44, …the purpose of the ESM plan is to expedite the implementation of a preferred plan…".

[821] *See* Proposed IRP, Exhibits 10-7 and 10-9, pages 10-11 and 10-13.

[822] PREPA's Response to Energy Bureau's ROI-1-3(f), August 2, 2019.

[823] *See* Proposed IRP, Exhibits 10-19 through 10-21, at pages 10-20 through 10-21.

[824] The ESM Scenario with lower levels of energy efficiency (either Low EE or No EE) contains a total of 3,060 MW of solar PV by 2025, inclusive of 2019 installations. PREPA's Response to Energy Bureau's ROI-9-1, Table 3 at page 12, December 6, 2019.

[825] *See* Proposed IRP, page 1-9.

[826] The ESM Scenario with lower levels of energy efficiency contains 1,160 -1,480 MW of battery storage by 2025. PREPA's Response to Energy Bureau's ROI-9-1, December 6, 2019.

Element	Quantity/Time Frame	Description/Comment
Accelerate Energy Efficiency and Demand Response	Establish EE programs at 2%/year savings.	The savings are "least cost resource(s).[827]
Enable Demand Response and Increased Distributed Generation	Reinforce distribution system. Enable 2-way flow, DG.	Appendix 4 – DG as modeled in Aurora, fixed projections of T&D level DG.
Convert Retired Plants to Synchronous Condensers	8 units across San Juan, Palo Seco, Aguirre over full planning horizon.	Retire and use SJ 9&10 for synchronous condensers within first 5 years of plan. Six months to convert 1 unit.[828]
Unit Retirements	Frame 5 peakers, Aguirre Steam 1 & 2, Costa Sur 5 & 6, San Juan 7 & 8	In first five years of plan, subject to availability of new generation resources.
Convert San Juan 5 & 6 to Gas	Underway.	June 2020 completion.[829]
Develop Land-Based LNG terminal in San Juan for new CCGT and SJ 5&6	Including pipeline. Increase volume from 50.4 MMcf/d for SJ 5&6 only (400 MW), to 93.6 MMcf/d to serve new 302 MW CCGT.[830]	Need is dependent on Palo Seco CCGT being implemented.
EcoEléctrica contract or new CCGT at Costa Sur	New contract 2020, through to 2032. Maximum capacity increases to 530 MW from 507 MW.	Reduced capacity payments; increased fuel costs.
Preliminary Activities for Ship-based LNG at Mayagüez for existing 4 x 50 MW GTs		Fixed Decision.
Preliminary Activities for Ship-based LNG at Yabucoa for new CCGT		Fixed Decision.

Source: Proposed IRP, pages 1-8 to 1-12; pages 8-44 to 8-46; pages 10-2 to 10-7.

591. In response to Energy Bureau's ROI -9-1 (d), PREPA described a revised Action Plan which essentially would increase the level of battery storage and solar PV resources in response to higher "net loads" due to the two different, lower levels of EE modeled (No EE and Low EE). The revised Action would install 2,760 MW of solar PV and 1,440 MW of battery storage by 2025.[831] The revised Action Plan makes no other changes except

[827] *See* Proposed IRP, page 10-22.

[828] *Id.* at page 10-4.

[829] Evidentiary Hearing, Testimony of Alfonso Baretty-Huertas, PREPA, February 3, 2020, morning session, 02:01.

[830] *See* Proposed IRP, page 7-11.

[831] PREPA's Response to Energy Bureau's ROI-9-1 (d), pages 15-16.

to note PREPA's expectation that EcoEléctrica will remain in service and no new combined cycle unit is expected for operation at Costa Sur.[832]

2. Intervenors

a. Environmental Defense Fund

592. EDF's expert witness Dr. Elizabeth Stanton recommends modeling runs with higher demand forecasts that incorporate lower EE estimates and lower build out of customer owned generation.[833] Dr. Stanton notes that Siemens did not test its modeling with sensitivities in forecasted EE, customer DG, or CHP.[834] She observed that the base, high, and low load forecasts all assume approximately a 50% drop in energy demand by 2038 when including forecasted EE and DG and combined heat and power resources.[835] Dr. Stanton contends that undercounting demand will result in less planned renewable generation to comply with the new RPS.[836]

593. In its Final Brief, EDF recommends the use of technology-neutral RFPs in future IRPs to "ensure the most up-to-date cost estimations are included in the modeling".[837] EDF also recommends use of technology neutral RFPs in this proceeding as a means for PREPA to ensure least-cost procurement of any needed capacity services, in addition to allowing the market to reveal the actual cost of resources.[838]

b. Local environmental organizations

594. LEOs expert witness Anna Somers notes several items in her testimony regarding Siemens' modeling. First, she notes that the $4.35/MMBtu transportation adder (liquefaction+ transportation+ margin) that is kept constant in nominal dollars would result in a decline in real dollar terms.[839] Ms. Sommers also observed a price separation between some of the gas units that may be related to a difference in an unspecified

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[832] *Id*. at page 17.

[833] EDF, Direct Testimony of Dr. Elizabeth Stanton, October 23, 2019, page 2.

[834] *Id. at* page 12.

[835] *Id.*

[836] *Id.* at page 15.

[837] EDF, Final Brief, March 6, 2020, page 56.

[838] *Id. at* pages 18-19, and 46.

[839] LEOs, Direct Testimony of Anna Sommers, October 23, 2019, page 25.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

transportation charge not described in the Proposed IRP.[840] Ms. Sommer notes that PREPA's workpapers for Sensitivity 5 do not reflect higher natural gas prices.[841]

c. Not-for-profit intervenors

595. The NFPs' expert witness Dr. Eric Ackerman advocates the use of Advanced Grid Planning that would be a more "bottoms-up" approach to planning.[842] Dr. Ackerman claims that this approach would help integrated distributed resources more comprehensively than the current approach used by PREPA and Siemens.[843]

d. Sunrun

596. Witness Christopher Raucher's testimony introduces the idea of VPPs that are a combination of solar and storage capabilities.[844] Mr. Raucher advances the idea that the VPPs would also support PREPA's MiniGrid concept by locating solar and storage facilities throughout the island.[845]

e. Wärtsilä

597. Wärtsilä's expert witness Brian Fladger filed Supplemental Testimony that summarized supplemental modeling conducted by Wärtsilä in reply to PREPA's response to ROIs. Witness Fladger conducted his modeling using Plexos, a different modeling software from Siemen's Aurora modeling framework.[846] Witness Fladger made the following adjustments to his model: 1) start-up costs; 2) different downtimes for RICE units; and 3) different variable operating and maintenance costs.[847] Mr. Fladger indicated that he was able to conduct his modeling based on inputs provided in PREPA's responses to requests for information.[848] His modeling analysis resulted in higher renewables and fewer CCGTs than PREPA's ESM scenario.[849] Specifically, Mr. Fladger observed that his model resulted in 909 MW of additional solar and storage; 530 MW of RICE units; 604 MW less CCGTs; and 464 MW less GTs.

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840 *Id.*

841 *Id.*

842 NFPs, Direct Testimony of Dr. Eric Ackerman,. October 22, 2019, page 12.

843 *Id.* at page 13.

844 Sunrun, Direct Testimony of Christopher Rauscher, October 23, 2019, page 2.

845 *Id.* at page 20.

846 Wartsilla, Supplemental Testimony of Brian Fladger, December 11, 2019, page 2.

847 *Id.*

848 PREPA's Response to Wartsilla's ROI, February 7, 2020 and February 9, 2020.

849 Wartsilla, Supplemental Testimony of Brian Fladger, December 11, 2019, page 2.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

3. Amicus Curiae

a. ACONER

598. In its *Amicus Curiae* Brief, ACONER states that the Proposed IRP will arbitrarily limit the use of renewable resources and storage resources in PREPA's resource plan, and that PREPA should consider procuring RECs from distributed generators.[850]

b. Rocky Mountain Institute

599. In its Amended *Amicus Curiae* Brief, RMI states that a "fundamental inadequacy" of the Proposed IRP is that the ESM Scenario is more expensive, in NPVRR terms, than alternatives such as S3S2 or S4S2. RMI states that PREPA's perceived technology risk associated with solar PV is not justified on technical grounds. RMI further notes that only the ESM Scenario, which is "not fully optimized", contains a plan to install new gas units at Mayagüez and Yabucoa in 2025, and no other expansion plans call for this resource. RMI asserts that PREPA's Preferred Resource Plan is overly reliant on natural gas and risks stranding investment in gas infrastructure. RMI also notes that PREPA's plan fails to appropriately incorporate distributed storage, noting that it could be dispatched for grid benefit, in support of a flexible resilient energy system that compensates customers who install such storage. RMI criticizes PREPA for its "flawed logic" and arbitrary weighting used in its "scorecard" approach in support of its ESM and S4S2 plans.[851]

4. Discussion and Findings

600. The resource plans that result from PREPA's execution of LTCE modeling runs across the various Scenarios differ in terms of the input assumptions used for resource costs and availability,[852] fuel price[853] and forecast load,[854] making meaningful comparisons between Scenario costs potentially difficult. However, the underlying results still allow the Energy Bureau to gauge which combination of resource options offers the likely lowest cost path for resource acquisition aligned with the requirements of Regulation

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[850] ACONER, *Amicus Curiae* Brief, November 1, 2019, pages 4 and 5.

[851] RMI, *Amicus Curiae Amended* Brief, December 20, 2019, pages 2, 3, 12, and 15-16.

[852] Scenario 3 uses lower costs for solar PV and battery storage resources, and increased availability in the early years of the planning horizon, relative to the other Scenarios.

[853] LTCE modeling conducted for the last sets of Requirement of Information used the new gas prices associated with the EcoEléctrica new PPOA contract terms. The Proposed IRP original modeling runs used lower gas prices for some years. *See* Table 5 in Part III(G). *See* PREPA's Response to Energy Bureau's ROI-9-1, December 6, 2019. *See* PREPA's Response to Energy Bureau's ROI-10-5, January 22, 2020.

[854] Five different sets of forecast loads were ultimately analyzed: base load with Full, Low, and No EE; high load with Full EE; and low load with Full EE.

9021, Act 17, and the provisions of earlier legislative direction,[855] since the Energy Bureau considers the effect of these factors when comparing the Scenario NPV costs.

601. The Energy Bureau has directly considered Act 17 public policy elements[856] that affect the Integrated Resource Plan, including in particular: compliance with the RPS,[857] aggressively reducing the use of fossil fuels,[858] and empowering consumers through EE strategies, DR provision, DG including community solar and microgrid creation, wheeling, access to renewable energy, resilience, and underground power distribution in urban centers.[859]

602. The Energy Bureau has carefully assessed the underlying assumptions used when comparing costs across Scenarios. The existence of numerous (*i.e.*, 87) modeled Scenarios arise from the combination of testing a few different input assumptions for each of three major parameter sets in the model: 1) load level net of EE effects, 2) supply resource characterization (*e.g.*, capital cost, pace of installation, gas availability), and 3) local resource requirements (*i.e.*, decentralized vs. centralized supply). The number of permutations modeled escalates when up to five different load levels are considered,[860] three different sets of capital costs are used for renewables and batteries,[861] multiple different gas availability options are tested,[862] and three different possible "local" reserve requirements are defined.[863] While this resulted in many modeling runs, it allowed PREPA to test, and the Energy Bureau to weigh, the relative robustness of a

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[855]*See* Act 57; Act 83; Act 120, § 3; Act 29-2009 § 13.

[856]*See* Act 17, including § 1.5, 2050 Energy Public Policy.

[857] *See* Act 17, § 1.6(7), "To reduce and eventually eliminate electric power generation from fossil fuels by integrating orderly and gradually alternative renewable energy while safeguarding the stability of the Electrical System and maximizing renewable energy resources in the short, medium, and long-term."

[858] *See* Act 17, § 1.5, 1.6.

[859] *See, e.g.*, Act 17, §1.5, (8)(c), "To promote the development of microgrids, particularly in essential service facilities as these are defined in Act 57-2014, and in remote areas, as a mechanism to promote the resilience and modernization of the distribution networks" and § 1.5(9)(h), "To install underground power distribution lines in urban centers, to the maximum extent possible, and upon conducting the pertinent analysis, in order to increase the resilience, rehabilitation, and repopulation of such urban centers, giving special attention to essential service facilities".

[860] Base, Low, High (all full EE); Base Low EE and Base No EE.

[861] Scenario 3 (S3) is defined to test the model results when using lower costs for renewables and batteries and allows for faster installation pacing. Most other Scenarios use mid-level costs; and some sensitivities use high costs for those resources.

[862] LNG ship-based or land-based; LNG available only in the north; LNG available in all locations.

[863] Strategy 2 constrains the model to require an eighty percent (80%) local reserve requirement; Strategy 3, fifty percent (50%); Strategy 1 uses only the thirty percent (30%) island-wide requirement.

given solution across a Scenario's different input assumptions, which is the intent of the Energy Bureau's Regulations in this regard.[864]

603. In addition, in all Scenarios considered, PREPA asserts a MiniGrid requirement that "critical load"[865] peak requirements must be met with fossil-fuel thermal resources,[866] and includes this constraint in all Scenarios, without providing any alternative modeling runs that remove this constraint. The Energy Bureau addresses this element when considering capacity resource builds for the different Scenarios in this Part of the Order, and further considers this when discussing MiniGrid issues in Part III(I) of this Final Resolution and Order.

a. "No Regrets" resources

604. The eighty-seven (87) different Scenarios share common resource elements (though with differing quantities of solar PV and battery storage across Scenarios) that are fully aligned with some of the core aspects of Act 17.[867] PREPA expressed "no regrets"[868] over inclusion in a Preferred Resource Plan of i) renewable energy and storage, ii) maximization of EE provision, iii) integration of DG, and iv) hardening of aspects of the T&D system.[869] The Energy Bureau **FINDS** that these specific "no regrets" elements, of i) renewable energy and storage, ii) maximization of EE provision, iii) integration of DG, and iv) hardening of aspects of the T&D system common to all resource plans except those run explicitly with No EE,[870] form the core of a Modified Preferred Resource Plan for PREPA, and **APPROVES** all four of these aspects of PREPA's Preferred Resource

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864 *See* Regulation 9021, §2.03(H)(2)(b).

865 PREPA defines critical load as "This load represents the peak consumption of the total load connected to feeders that serve any critical customer and that during the restoration effort may be taken together with these critical customers. Also, for the transmission connected load, it represents the entirety of the load connected to the substations, although some of it (perhaps the majority) may not be critical, but rather priority." IRP Appendix 1, page 2-4 and 2-5.

866 *See* Proposed IRP, Appendix 1, Section 2.3 MiniGrid Design, page 2-6, "The critical load must be served by thermal resources only ensuring full coverage right after the event and before the renewable generation (PV) and battery storage BESS are back online".

867 For example, Act 17 specifically notes the importance of energy efficiency, renewable resources, distributed generation and distribution system undergrounding.

868 Evidentiary Hearing, February 7, 2020, morning session, 01:32.

869 All Scenarios contain renewable energy and storage resources as part of the modeled resource solution. All Scenarios contain at least PREPA's inclusion (as a fixed input) of over 1,000 MW of distributed generation, with the potential for more DG. All Scenarios assume PREPA's hardening of at least some parts of the T&D system. All Scenarios except those explicitly modeled to see the effects of No EE contain some level of energy efficiency as a resource.

870 All Scenarios contain energy efficiency as a demand modifier (or load reducer) to base, low or high "gross" loads, except for those Scenarios specifically requested as part of ROIs 9 and 10, the results of which are used to gauge the effects of resource planning under different levels of energy efficiency provision.

Plan, with specific quantities to be addressed further in this Final Resolution and Order as part of a Modified Action Plan.

605. The Energy Bureau also **FINDS** that conversion of retired steam generating plants to synchronous condensers in support of voltage requirements common to all Scenarios that use increasing levels of inverter-based generation (from solar PV and battery energy storage) is reasonable,[871] and **APPROVES** PREPA's plan to convert units to synchronous condensing operation, subject to PREPA's further plans for additional study[872] and in a manner aligned with both steam plant retirement schedules and need, as will be addressed further in this Final Resolution and Order.

606. For other elements of PREPA's proposed Preferred Resource Plan, specifically as related to new fossil-fueled generation resources, the Energy Bureau discusses the applicable analysis in support of the Energy Bureau's further findings in the following sub-parts.

b. Modeling results summary - NPVRR

607. PREPA's resource plan results from its original filing, shown in Tables 7 and 8 above, indicate the following for the net present value of revenue requirement (NPVRR), which under Regulation 9021[873] serves as the primary criterion for selection of a Preferred Resource Plan:

- Scenario S3S2 is the lowest cost Scenario for baseload levels[874] and is also the lowest cost Scenario for the high gas price sensitivities (reflective of baseload levels);[875]
- S4S2 is the lowest cost Scenario for high and low load levels; and is lower cost than S3S2S8 under base loads (S3S2S8 reflects a sensitivity to

[871] *See* Proposed IRP, page 1-10: "With the retirement of PREPA's older steam units and the introduction of greater inverter based generation from solar, wind and batteries, studies carried out under this Proposed IRP (see Appendix 1) indicate that the PREPA system will require synchronous condensers to increase the short-circuit level and provide minimum levels of voltage stability for the inverter based resources to operate reliably. The adequacy of the system short circuit level is assessed in the Industry by determining the Short Circuit Ratio as the ratio of the short circuit level in the system to the installed inverter-based resources; typically values below 1.5 are problematic. Without the synchronous condensers the ratio may be under 1.0 for PREPA resulting in an unstable system."

[872] *See* Proposed IRP, pages 1-10 and 10-4.

[873] *See* Regulation §2.03 (H)(2)(D)(i).

[874] Table 7, "Base Load" grouping, S3S2B NPVRR equals $13.84 billion. Proposed IRP, page 8-10, "As can be seen in the prior table and chart above, Scenario 3 Strategy 2 (S3S2) provides the lowest NPV ($13.8 billion) NPV for the baseload forecast but has higher costs than Scenario 4 Strategy 2 for the low load forecast and about the same to S4S2 and the ESM for the high load forecast."

[875] Table 8, "High Gas Price" grouping, S3S2S5B NPVRR equals $14.81 billion. High gas price sensitivities were run only on base load, "full EE" cases.

Scenario 3 Strategy 2, adjusted to reflect higher "base" level renewable costs);[876] and

- ESM is never the low-cost Scenario, compared to S4S2 or S3S2, for any of Base, High or Low load levels.[877] ESM remains higher cost than S4S2 (baseload) under sensitivities reflecting either higher or lower cost battery storage and solar PV costs. However, ESM is shown as lower cost than the NPVRR (as corrected)[878] for the sensitivity S3S2S8 (baseload).
- Scenario 1 generally is a higher cost Scenario compared to either Scenario 3 or Scenario 4, but under "Strategy 1" (more centralized supply), it is lower cost than the ESM plan for baseload. Scenario 1 is higher cost than ESM under Strategy 2 or 3 considerations, and under high load.
- Scenario 5 is lower cost than the ESM plan, under baseload conditions, but costlier than Scenarios 3 or 4. Scenario 5 does perform better than Scenario 4 and the ESM plan under low or high solar PV and battery cost sensitivities.

608. The accompanying text in the Proposed IRP[879] describes the broad pattern of NPVRR modeling results for the Scenarios. PREPA states that S4S2 and the ESM Plan "were determined to be practical and low cost plans that contain the recommended path forward."[880] However, the data and the IRP narrative confirm that Scenario 3 Strategy 2, and not S4S2 or the ESM plan provides the lowest cost for the baseload forecast, though it also notes that S3S2 assumes a deeper reduction in renewable and storage costs "and may not be realized".[881] PREPA states, concerning S3S2, "…we see this case as a guide to potential enhancements that can be considered if both the cost of PV

[876] Table 7, "High Load" and "Low Load" groupings. Table 8, "Normal Cost PV/Batteries" S3S2S8B – corrected" NPVRR equals $14.82 billion, compared to Table 7, "Base Load" NPVRR value for S4S2B equal to $14.34 billion. The original S3S2S8 NPV result from PREPA's modeling was $14.36 billion, as seen in Table 8 ("Normal Cost PV/Batteries – S3S2B") and on IRP Exhibit 8-3, slightly higher than the S4S2B NPV of $14.34 billion, although lower than the ESM NPV of $14.42 billion. PREPA's response to the Energy Bureau's ROI 9, December 6, 2019, on page 9-3 (a) corrected PREPA's original filing, which had only adjusted the cost of the solar PV and not the battery storage resource to reflect mid-range (2018 NREL Annual Technology Baseline) rather than low-cost resources. The Scenario definition includes lower costs for both solar PV and battery storage resources. This correction resulted in both ESM and S4S2B being lower cost than S3S2S8.

[877] *See* Proposed IRP, Exhibit 8-3, pages 8-8 to 8-9, first column listing "NPV @ 9% 2019-2038 k$", comparing ESM (base) $14.43 billion to S4S2B $14.35 billion, and S3S2B $13.84 billion; ESM (High) $15.70 billion to S4S2H $15.25 billion, and S3S2H $15.19 billion; and ESM (Low) $13.95 billion to S4S2L $12.87 billion, and S3S2L $13.24 billion.

[878] Energy Bureau's ROI 9, October 29, 2019. PREPA's Response to 9-3 (a), Attachment 3, "S3S2S8B_Metrics_Base_Case_Adjusted.xls"provided on December 6, 2019.

[879] *See* Proposed IRP, pages 8-10 to 8-13.

[880] *See* Proposed IRP, page 8-11.

[881] *See* Proposed IRP page 8-10.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

declines faster than the base case and greater amounts of renewable[s] can be safely operated".[882]

609. PREPA also notes that the three Strategy 1 baseload cases, S4S1, S5S1 and S1S1, are either lower cost[883] or "similar"[884] in cost to S4S2 and ESM, but states that those Strategy 1 cases are not determined to be the preferred resource plan due to their incorporation of a "centralized strategy" and concerns of concentration of generation in the south, high levels of "energy not served" and medium and longer-term curtailment issues.[885]

610. When questioned why Scenario 3 Strategy 2, as the lowest cost plan, was not included as part of a preferred resource plan, PREPA reiterated that:

> If Scenario 3 assumptions on low cost of renewable[s] materialized over the planning period from a purely economic point of view this would be a preferred resource plan and we incorporate it indirectly when we express that it provides an indication of a future development if these lower cost[s] did materialize and the renewable implied by the plan could be effectively be incorporated....
>
> In summary this plan shows a potential path forward if the cost assumptions and integration do materialize.[886]

611. PREPA asserts that implementation of high levels of solar PV as in Scenario 3 "would be a significant challenge and could be difficult to achieve for practical reasons ... increasing the risk of curtailment ... and putting strain and reliance on the energy storage".[887] PREPA restates this in response to an information requirement: "Other practical problem is the dependence on PV and over the long term the entire installed thermal capacity in this plan would only cover 44% of the expected peak demand versus 62% in the S4S2B".[888] PREPA notes that:

> [during] daytime hours the PV will be several times the system load and most of it will be going to storage, that is expected to manage its

[882] *Id.*

[883] *See* Proposed IRP, page 8-10, "Scenario 4 Strategy 1 (S4S1) and Scenario 5 Strategy 1 (S5S1) and provides the second and third lowest NPV results (14.0B and 14.3B) for the base load forecast". The lowest cost NPV is S3S2.

[884] *See* Proposed IRP, page 8-11, "The NPVs of Scenario 4 under Strategy 2 (S4S2) ($14.35B) and Scenario 4 under Strategy 3 (S4S3) ($14.41B) are very similar, however Strategy 2 has the lower value as well as the value of deemed energy not served and hence preferred."

[885] *See* Proposed IRP, page 8-10 and 8-11.

[886] PREPA's Response to Energy Bureau's ROI-1-54(a), July 11, 2019.

[887] *See* Proposed IRP, page 8-72.

[888] PREPA's Response to Energy Bureau's ROI-1-54 (c), July 11, 2019.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

> intermittency. There is no experience with these levels of generation and in general we found that the dispatch models have difficulty in finding a solution. So, we are not assuming that the storage is not working properly, we are basically concerned on the practical feasibility of running such a system. In fact, the comparable values for S4S2B are also challenging; 2,820 MW of PV equal to 159% of the demand long term and 1,614 MW of storage 92% of the demand and we suggest caution and have a learning curve as we integrate these levels of renewable.[889]

612. However, PREPA does explicitly state that this is a long-term concern, and notes that:

> in the short term, both the S3S2B and S4S2B[890] call for important levels of PV (2,820 MW and 2,220 MW) and have the same storage levels (1,320 MW), so the key differentiator between these plans in the short term decisions is that S4S2B does call for the development of the new CCGT in the north (Palo Seco), while in S3S2B this is not developed and large amounts of PV are installed after 2025 (4,140 MW by 2038 in S3S2B).[891]

613. The Energy Bureau **ACCEPTS** in particular PREPA's statement above that the "key differentiator" in the short-term, between Scenario 3 and the ESM Plan or Scenario 4, is the decision concerning whether or not there is development of a new combined cycle unit in the north, at Palo Seco.

614. Based on the initial filing and the responses to the Energy Bureau First ROI,[892] PREPA's rationale for excluding S3S2B from consideration as a Preferred Resource Plan is based on two underlying assumptions: first, the lower cost assumption regarding renewable energy, and second, the high ratio of installed solar PV to peak demand in the later years of the planning horizon. Concerning the first assumption, PREPA notes that S3S2 indeed would be "a preferred resource plan" if the lower costs did materialize.[893] The Energy Bureau **FINDS** that PREPA improperly excluded S3S2 from consideration as part of a Preferred Resource Plan due to the unfounded cost assumption concerns that can be addressed and tested as part of the competitive procurement processes set forth in the Action Plan.

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[889] PREPA's Response to Energy Bureau's ROI-1-54 (b), July 11, 2019.

[890] In the information requirement response, this specific phrasing contains a typographical error, where the term "S4S2B" as footnoted here was labeled as "S3S2B". It is clear from the comparative context of the sentence that it is describing a comparison between S3S2B and S4S2B.

[891] PREPA's Response to Energy Bureau's ROI-1-54(a), July 11, 2019.

[892] PREPA's Response to Energy Bureau's ROI-1-54, July 11, 2019.

[893] PREPA's Response to Energy Bureau's ROI-1-54(a), July 11, 2019.

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DE PUERTO RICO

615. In regard to the second issue, concerning the level of solar PV as a percentage of peak load in the out years of the analysis, as PREPA itself notes, in the early years of the period, S3S2 and S4S2 contain similar, high levels of solar PV; PREPA's concern in this regard is limited to the later years. As seen in the details of hourly modeling on summer peak load days for later years,[894] the Energy Bureau notes that PREPA's statement that S3S2 solar PV output is "almost double the forecasted peak load"[895] does not include the load of battery energy storage during peak solar output times. The Energy Bureau **FINDS** that this out-year concern is of lesser importance when considering the additional load of battery energy storage systems during times of high solar PV output. The Energy Bureau also **FINDS** that any concerns in this regard can readily be addressed in subsequent IRP cycles, and the concern is not sufficient to exclude S3S2 from consideration as part of a preferred resource plan.

616. Tables 9 and 10 above indicate that Scenario S3S2 remains the lowest cost Scenario (for the comparisons arising from modeling in response to the Energy Bureau's Ninth and Tenth Requirements of Information) when considering both 1) lower levels of EE affecting load, and 2) the effect of directly incorporating the specific terms of the EcoEléctrica new PPOA and "refining" the LTCE modeling to better optimize the levels of battery storage and associated reduced solar PV curtailment.[896]

617. PREPA's responses to the Energy Bureau's Ninth ROI[897] provides the results of LTCE modeling runs with Low EE and No EE. Table 9 above demonstrates that Scenario S3S2 is lower cost than either S4S2 or ESM, as the NPVRR is lower for both of these effectively increased (from base Full EE) loading levels. The results in Table 10 are reflective of the responses provided by PREPA to the Energy Bureau's Tenth ROI, also show S3S2 as a lower cost option than S4S2, for three different load levels: base (with Full EE), Low EE, and No EE, indicative of a robust result for S3S2 under different load levels.[898]

618. PREPA produced a sensitivity, S3S2S8B, to reflect the costs of the S3S2B Scenario if the solar PV and battery storage build out *quantities and timing* remained the same as initially seen in S3S2B, but the solar PV and battery storage *costs* were adjusted to

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[894] PREPA Workpaper for nodal hourly run, S3S2, for July 1, 2028, battery load is roughly 2,000 MW at solar PV peak output; also, as confirmed by PREPA. Evidentiary Hearing, February 6, 2020, afternoon session, 23:00.

[895] *See* Proposed IRP, page 8-10.

[896] PREPA's Response to Energy Bureau's ROI-9-1, December 6, 2019; PREPA's Response to Energy Bureau's ROI-10-5, page 10, December 13, 2019. PREPA was asked to produce modeling results comparing the NPVRR "with" and "without" the new EcoEléctrica PPOA terms, while simultaneously using load levels reflecting cases with Low EE and No EE adjustments to the base load forecast. PREPA also "refined" the optimal resource levels, to account for Aurora modeling limitations, when finalizing the results.

[897] PREPA's Response to Energy Bureau's ROI-9-1(c), December 6, 2019.

[898] PREPA's Response Energy Bureau's ROI-10-5, January 22, 2020.

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reflect normal or base costs, rather than lower cost assumptions made in S3S2B.[899] S3S2S8B NPVRR (initially filed) as seen in Table 8 was $14.36 billion, or $514 million higher than the original Scenario S3S2B, but essentially the same cost as S4S2B,[900] and still lower cost than the ESM Scenario which was $14.43 billion. However, subsequent corrections made to PREPA's initial estimates of S3S2S8B costs increased the NPVRR to $14.8 billion.[901] These corrections result in the solar PV and battery storage cost sensitivity to Scenario 3 Strategy 2 (S3S2S8B) being higher cost than S4S2B and the ESM case, rather than being similar to those results: S3S2S8 is 3.3% higher cost than S4S2B, and is 2.8% higher cost than ESM (baseload).[902]

619. The Energy Bureau **FINDS** that all Scenario analyses including the final LTCE modeling runs completed in response to the Energy Bureau's Ninth and Tenth ROIs[903] point to a broad conclusion that the underlying installation pace and cost of solar PV and battery energy storage procurement is a critically important piece of information, and ultimately would inform what the true least cost Scenario would be, in combination with confirming the costs associated with a new CCGT build at Palo Seco.[904] The Energy Bureau **FINDS** that if solar PV and battery storage costs are roughly in line with the assumptions made for Scenario 3, and costs for a CCGT at Palo Seco remain as modeled (or are higher), then it is clear that S3S2 is the lowest cost plan and should directly inform PREPA's Preferred Resource Plan.

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899 *See* Proposed IRP, page 5-7. Sensitivity 8 "Applies to Scenario 3, base cost of renewable generation and storage". Scenario 3 as defined uses the NREL 2018 Annual Technology Baseline (ATB) (IRP, page 6-19), "Low Case" costs (Proposed IRP at page 5-4) and reflected in the data in Proposed IRP's Exhibit 6-35 at page 6-26.

902 PREPA's Response to Energy Bureau's ROI-1-54(a), August 2, 2019. PREPA noted, "However, if the renewable capital cost were equal to our base forecast then this plan (S3S2S8B) would have similar present value as for example the S4S2B; $14.36 billion versus $14.35 billion, but its capital cost is 28% higher and would be heavily affected by higher (than the base) renewable prices."

901 PREPA's Response to Energy Bureau's ROI-9-3(a), November 27, 2019. The initial Sensitivity 8 to S3S2B increased the solar PV costs, but not the battery storage costs, to reflect base costs instead of low costs, as revealed through the Energy Bureau's examination of the "production cost" tab of the metric file for S3S2S8. *See* also the response to 9-3 (b) and 9-3 (c) in which PREPA also made minor corrections to the original NPVRR values for S3S2B (to $13.858 billion, vs. $13.843 billion original) and S4S2B (to 14.353 billion, vs. $14.350 billion original).

902 Table 2, corrected S3S2S8B, NPV equal to $14.82 billion. Table 1, ESM (base) NPV equal to $14. 42 billion, and S4S2B NPV equal to $14. 34 billion. PREPA's Response to Energy Bureau's ROI-9-3(b), November 27, 2019. Based on the initial filing results for the ESM case, and the corrected filing results for S4S2B.

903 PREPA's Response to Energy Bureau's ROI-9, November 27, 2019, at page 9-1; PREPA's Response to Energy Bureau's ROI-10-5, January 22, 2020, at page 10-5.

904 As noted in Part III (E) at paragraph 276, the capital costs associated the CCGT generation could be as high as 30% more than the base assumptions used in the modeling. As noted in Part III (F), a sensitivity to LNG infrastructure costs in the north was modeled in response to Energy Bureau ROI-6-5, and found that higher costs would cause the S4S2B Scenario to no longer select a new CCGT at Palo Seco.

620. As noted in Part F, PREPA modeled as a sensitivity to S4S2B a condition where LNG infrastructure costs in the north were high. In that modeling run, a new CCGT at Palo Seco was **not** selected.[905] The Energy Bureau **FINDS** that the additional risk of potentially higher LNG infrastructure costs associated with a land-based LNG terminal in the north and a new CCGT at Palo Seco supports selection of a Modified Preferred Resource Plan that does not include a new CCGT at Palo Seco.

621. Even if those S3S2 solar PV and battery cost assumptions are incorrect, whether or not S3S2 would remain a least cost plan would depend on the actual prices that would be seen for solar PV and battery resources, which is difficult to discern absent price discovery through competitive procurement processes.[906] If the prices of solar PV and battery storage resources were midway between the costs represented in Scenario 3, and those of Sensitivity 8 applied to Scenario 3, then Scenario 3 would be slightly less expensive than the ESM Plan, and roughly the same cost as Scenario 4.[907]

622. The Energy Bureau **FINDS** that of the resource plans put forward by PREPA, the actual least-cost plan will depend upon the whether or not actual costs in response to planned procurement actions will reflect solar PV and battery storage cost assumptions made for Scenario 3,[908] or different (*i.e.*, higher) cost assumptions used for the other Scenarios (S1, S4, S5, ESM)[909]. Under the 2018 NREL Annual Technology Baseline (ATB) "low" case assumptions for solar PV and battery energy storage used to define Scenario 3, the resource plan S3S2 inclusive of all loading scenarios has clearly been shown to be the lowest cost plan considering the net present value of revenue requirement[910], as acknowledged by PREPA.[911] S4S2 is shown to be the lowest cost decentralized supply plan[912] if the solar PV and battery cost assumptions reflect the 2018 NREL ATB "mid"

[905] Response to Energy Bureau ROI-6-5 a), pertaining to S4S2B, October 15, 2019. "With higher LNG infrastructure costs, the Aurora model does not find economic to build any new CCGTs across the island. Instead, decides to maintain Ecoelectrica operating for a longer period of time through 2035, and run existing units at higher capacity factors."

[906] PREPA's Action Plan includes such procurement processes for solar PV and battery energy storage. *See* Proposed IRP, pages 10-2 and 10-3.

[907] From Table 1 above: Scenario S3S2B NPV is $13.85 billion. Scenario S3S2S8B NPV is $14.82 billion. The midway point between these two values is $14.33 billion. ESM (base) NPV is $14.42 billion. S4S2B NPV is $14.34 billion.

[908] Presumption of 2018 NREL ATB "low" costs.

[909] Presumption of 2018 NREL ATB "mid" costs.

[910] *See* Proposed IRP, Exhibit 8-3.

[911] *See* Proposed IRP, page 8-10.

[912] Strategy 2 reflects the most decentralized supply plan strategy.

case assumptions, which was the then-current NREL ATB version at the time of PREPA's filing but has since been superseded by NREL's next two releases.[913]

623. As noted by PREPA, there are similarities in early year solar PV and battery energy storage resource development between S3S2 and S4S2, as the key differentiator is the presence or absence of a planned new combined cycle at Palo Seco. Given that the least cost scenario would be dependent on the materialization of the lower cost solar PV and battery storage input assumptions, the Energy Bureau **ORDERS** PREPA to develop solar PV and battery storage resources at the S3S2 level in accordance with competitive procurement protocols as specified in the Modified Action Plan.

624. The Energy Bureau **FINDS** that NPV cost differences between plans vary in significant part because cost and availability assumptions differ across Scenarios. The Energy Bureau **FINDS** that planned competitive procurement actions as included in PREPA's Action Plan[914] must be undertaken to resolve the uncertainties around what actual costs will likely be for solar PV and battery storage resources.

625. The S3S2B Scenario emits less carbon dioxide than the ESM (Base) or S4S2B Scenario, as noted in paragraph 576 above. PREPA confirmed at the hearing that if carbon pricing was explicitly considered, then a Scenario with more carbon emissions would effectively be penalized more than a Scenario with lower carbon emissions. Given the directions in Act 17 to consider the effects of climate change in the integrated resource planning process, and noting that Scenario S3S2B has a lower carbon emission profile than the ESM or S4S2B Scenario, the Energy Bureau **FINDS** that from a climate change mitigation perspective, Scenario S3S2B is preferable to either the ESM or S4S2B Scenario because it contributes towards mitigation of climate change effects relative to those other Scenarios.

626. As noted, Section 1.9(3)(H) of Act 17 states that the integrated resource plan shall include, but not be limited to PREPA's environmental impact assessments related to air emissions and water consumption, solid waste, and other factors such as climate change. The Energy Bureau **FINDS** that although PREPA's IRP does consider environmental impact assessments, it did not fully and adequately address climate change. Therefore, the Energy Bureau **ORDERS** PREPA in its next IRP to do an environmental impact assessment related to climate change as required by law, and must explicitly include carbon price scenarios in any initial modeling exercises.

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[913] The 2019 NREL ATB version was released on August 1, 2019. https://www.nrel.gov/news/program/2019/updated-baseline-cost-performance-data-electricity-generation-technologies.html. The 2020 NREL ATB version was released on July 9, 2020. https://www.nrel.gov/news/program/2020/2020-annual-technology-baseline-electricity-data-now-available.html.

[914] PREPA plans competitive procurements of BESS and PV. See Proposed IRP pages 10-2 and 10-3.

c. Steam plant retirements

627. The Tables in Appendix C of this Final Resolution and Order contain PREPA's modeled retirement dates associated with all older oil-fired and gas-fired steam plants on PREPA's system for all Scenarios. Those plants include units at Aguirre, San Juan, Palo Seco, and Costa Sur. Generally, the modeling results reflect retirement of all older steam units by roughly 2025, to meet MATS requirements (for oil-fired units) and for overall economic reasons, once sufficient replacement capacity is in place from new battery, fossil-fueled peaking resource, and/or gas-fired combined cycle resources. PREPA also directly indicated the intended retirement for the Frame 5 peakers, Aguirre steam units 1 & 2, Costa Sur steam units 5 & 6, and San Juan steam units 7 & 8 in the Action Plan section of the Proposed IRP, within the first five (5) years of the resource plan.[915]

628. PREPA stressed that the availability of new generation resources would be required to allow for the retirements.

629. These oil-fired steam generation units, and Costa Sur 5 & 6, comprise the majority of PREPA's owned or contracted capacity resources. Constructed in the 1960s and 1970s, these units are approaching the end of their service lives. With the exceptions of Costa Sur 5 & 6, they do not comply with MATS.[916] They are inflexible in operation, exhibit high forced outage rates, and are relatively inefficient. Retiring these units will lower costs, improve reliability, and help achieve MATS compliance.

630. The Energy Bureau **FINDS** that PREPA should retire the older, oil-fired steam assets, roughly in order of declining cost to operate (and in consideration of retirement sequencing by unit to align with synchronous condenser conversion) as soon as they are no longer necessary for reliable system operations. The Energy Bureau also **FINDS** that PREPA should retire Costa Sur 5 & 6 when reliable system operation can be supported without their presence, after retirement of the oil-fired resources. The Energy Bureau **APPROVES** the retirement plans for PREPA steam units in accordance with PREPA's caveats[917] indicating a need for replacement capacity, assurance of meeting the overall reliability needs, and in alignment with more specific timing thresholds described in the Modified Action Plan.

631. The Energy Bureau **ORDERS** PREPA to file quarterly updates and compliance reports associated with the plans for retirement of these units, with specific reporting and compliance information requirements and dates as described in the Modified Action Plan. The Energy Bureau **ORDERS** PREPA to include in these regular updates and

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[915] *See* Proposed IRP, Exhibit 10-3, page 10-5.

[916] *See* Proposed IRP, page 4-24, Exhibit 4-25.

[917] *See* Proposed IRP, Part 9, Caveats and Limitations, No. 17, page 9-4.

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compliance reports all information on the status of conversion to synchronous condensing where applicable.

d. Energy efficiency value across the resource plans

632. Comparing Scenarios with different levels of EE, but with the same set of input assumptions provides an assessment of the differential effects of EE resource deployment, when those deployment costs are included. Table 13 below contains a subset of the information from Table 10, comparing the NPVRR for Scenario 3 and Scenario 4 resource plans with full EE, Low EE, and No EE. The presence of EE allows for reduced total loading, reduced fossil fuel consumption, reduced need for deployment of solar PV and battery energy storage to meet requirements, and lower total system losses. All of those components of benefit are reflected in the NPVRR for the individual Scenarios, seen in Table 13 below. Table 13 shows the "Energy Efficiency Value", which is the net benefit accruing to ratepayers in the form of lower NPVRR when including the costs of the EE resources.

633. This table illustrates the clear benefit to Puerto Rico ratepayers over the planning horizon of deploying as much EE, at least up to the "full EE" level modeled in the original Scenarios, as is possible. Scenario S3S2 results in net benefits to ratepayers of $480 million over the planning horizon by deploying a resource plan that includes a "low" level of EE (compared with No EE). Deploying a "full" level of EE in that Scenario secures an additional $1.14 billion in net benefits. Combined, using a full measure of EE resources over the planning horizon would save ratepayers a net amount of $1.62 billion (NPV). Under Scenario 4, the pattern is similar, though savings are even greater because of the use of more expensive (than solar) gas-fired resources in that Scenario.

Table 13. Estimate of Energy Efficiency Value from Scenario Modeling Results – ROI 10-5 - $ Billions (NPV)

20-Year NPVRR (Billions)	S3S2	S4S2
Base Load No EE	$16.74	$17.74
Base Load Low EE	$15.98	$16.68
Base Load Full EE	$14.14	$14.82
20-Year NPVRR Savings with Additional EE (Billions)		
From No EE to Low EE	$0.76	$1.06
From Low EE to Full EE	$1.83	$1.86
From No EE to Full EE	$2.60	$2.92
20-Year Energy Efficiency Costs, NPV (Billions)		
From No EE to Low EE	$0.29	$0.29
From Low EE to Full EE	$0.69	$0.69
From No EE to Full EE	$0.98	$0.98

Net Benefits (NPV) Associated with EE Scenarios (NPVRR Savings less EE Costs), NPV (Billions)		
From Zero EE to Low EE	$0.48	$0.77
From Low EE to Full EE	$1.14	$1.17
From Zero EE to Full EE	$1.62	$1.94

Source for NPVRR values: PREPA NPVRR from metrics files and Proposed IRP Exhibit 8-3, as listed in Table 10 of this Final Resolution and Order. Source for energy efficiency costs: PREPA metrics files.

634. The Energy Bureau **FINDS** that the NPV cost differences between Scenarios whose main input assumption difference is load (due to different levels of EE) is a direct indication of the net value to ratepayers of deployment of EE resources, when EE costs are also considered. When directly compared with PREPA's estimated costs for EE,[918] the NPV cost difference indicates that EE benefits that arise from lower net loads always exceed EE costs.[919] Thus the Energy Bureau **FINDS** that PREPA's correctly determined finding that "[e]nergy efficiency is always the least cost resource and lower demand at far less cost than new supply and associated transmission and distribution".[920] The Energy Bureau's modification of PREPA's Action Plan reflects the inclusion of EE resource deployment as a pillar of a Modified Preferred Resource Plan.

635. The Energy Bureau **FINDS** that a maximum level of EE deployment should be a core provision of an approved Preferred Resource Plan.

e. PREPA's selection of ESM as Preferred Resource Plan

636. As originally modeled under baseload conditions, PREPA's Preferred Resource Plan, the ESM Scenario, is more costly on an NPV basis than Scenario 4 and Scenario 3 plans under "Strategy 2", the most decentralized approach[921] to providing supply.[922] The ESM plan under high load or low load conditions is also more costly than either S4S2 or S3S2.[923] Under high gas price sensitivities, the ESM Scenario (baseload) is more costly

918 The estimated costs for EE are included in the metrics files for each Scenario but are not considered part of the total cost when PREPA tabulates NPV of revenue requirement.

919 Table 13 above shows that S3S2B (Full EE) vs. S3S2B (No EE) leads to a net customer savings of $1.62 billion (NPV over the 2019-2038 period). For S4S2, the net customer savings for EE effects is $1.94 billion. These savings are directly computed from the difference in NPVRR between Full EE and No EE, less the costs for Full EE; this computation is done for each of Scenario S3S2, and S4S2.

920 *See* Proposed IRP, page 10-22.

921 *See* Proposed IRP, page 1-3. Strategy 2 "Reflects a system of more distributed, flexible generation, emphasizing resiliency and closer proximity of generation sources to the customer."

922 Table 1. The ESM Scenario is $577 million (4.2%) more costly than S3S2B and is $81 million (0.6%) more costly than S4S2B.

923 Table 1. The ESM Scenario is $99 million more costly than S4S2, and $63 million more costly than S3S2 under high load conditions. It is more than $1 billion more costly than S4S2, and more than $700 million more costly than S3S2 under low load conditions.

than either S4S2 or S3S2.[924] These load and gas price sensitivities to the originally filed LTCE modeling runs are key indicators used to assess the extent to which a plan is economically robust across variations in key assumptions. The Energy Bureau **FINDS** that the ESM Plan does not demonstrate economic benefit relative to competing plans across these multiple dimensions.

637. Under conditions modeled in PREPA's Response to Energy Bureau's ROI-9-1, *e.g.*, varying load levels due to different amounts of EE, and incorporating different input assumptions with respect to the new PPOA for EcoEléctrica,[925] the ESM Scenario remains costlier than S3S2, but is seen to be slightly less costly than S4S2.[926]

638. Under conditions modeled by PREPA in response to ROI 10, S3S2 is also seen to be the lowest cost Scenario, although ESM was not directly included in that modeling exercise. Modeled conditions for the response to ROI 10[927] included the same EcoEléctrica new PPOA terms as used for modeling in response to the Energy Bureau's ROI and also included refinements to battery storage optimization in order to reduce solar PV curtailment and reduce overall system costs.

639. To address concerns with whether Scenario 3 would remain the lowest-cost Scenario if solar PV and battery energy storage costs were higher than its original lower cost assumptions,[928] sensitivity 8 was defined, and a limited number of S3S2S8 modeling runs were executed. S3S2S8B was seen to be higher cost than the ESM plan, though the Energy Bureau notes that this sensitivity result is but one Scenario result among a number of relevant Scenarios that do not show ESM to be the least cost Scenario.

640. PREPA's inclusion of new gas infrastructure (LNG) for possible generation at Yabucoa and Mayagüez[929] in the ESM Plan are not supported by LTCE modeling in any Scenario result, and PREPA's indication that such infrastructure provides a "hedge" against

[924] Table 2. The ESM Scenario is $789 million more costly than S3S2S5B, and $356 million more costly than S4S2S5B.

[925] PREPA's Response to Energy Bureau's ROI-9-1, November 13, 2019 memo, "ROI 9 Assumptions for Modeling".

[926] Table 3. ESM is $383 million (2.4%) more costly than S3S2 under "low energy efficiency" loading, and $833 million (5.0%) more costly than S3S2 under "no energy efficiency" loading. ESM is $163 million (1.0%) less costly than S4S2 under "low energy efficiency" loading and is $305 million (1.9%) less costly than S4S2 under "no energy efficiency" loading.

[927] PREPA's Response to Energy Bureau's ROI-10, January 22, 2020, pages 7-9.

[928] Scenario 3 uses NREL 2018 ATB "low cost" rather than "normal cost" projections for solar PV and battery energy storage resources. Proposed IRP page 5-4; Exhibit 6-35 (solar PV NREL "low" case); Exhibit 6-40 (battery storage NREL "low" case).

[929] These are specific ESM Plan elements. *See* Proposed IRP, Section 1.2.3, pages 1-11 and 1-12, numbers 10 and 11; *See* Proposed IRP, Part 10, Action Plan, page 10-7.

higher load[930] is not supported by any evidence. PREPA also offers the LNG infrastructure at those sites as a hedge against not being able to develop a combined cycle unit at Palo Seco. Under S3S2 for all loading Scenarios, no combined cycle at Palo Seco is included. Even under S4S2, under a number of Scenarios the combined cycle is not required until 2028.

641. The Energy Bureau **FINDS** that PREPA has not supported its claim that additional gas infrastructure at Mayagüez and Yabucoa, as contained in the ESM Scenario as a "fixed decision", is needed. The Energy Bureau **DETERMINES** that it is unreasonable in this IRP cycle to consider expenditures for such LNG infrastructure as part of this IRP's preferred resource plan. The Energy Bureau **FINDS** that it is not reasonable to plan for such backup gas delivery locations.

642. The Energy Bureau also **FINDS** that PREPA did not rely on NPVRR as the primary criterion when choosing a Preferred Resource Plan as required by Section 2.03(H)(2)(d)(i) of Regulation 9021, and **REJECTS** PREPA's ESM Plan as the Preferred Resource Plan. The Energy Bureau **FINDS** that PREPA has not provided sufficient quantitative or qualitative support to waive provisions from Regulation 9021 that require that the primary criterion for selection of a Preferred Resource Plan is minimization of the present value of revenue requirements.

643. PREPA's inclusion of fixed decisions in the Preferred Resource Plan is not supported for all elements, especially for new peaking resources, and for gas infrastructure at Mayagüez and Yabucoa. PREPA's inclusion in the ESM plan of a new combined cycle unit at Palo Seco, for operation by 2025, discussed further in this Final Resolution and Order below, is also predicated on a fixed decision. The lowest cost S3S2B resource plan does not include a new combined cycle unit at Palo Seco, and some of the lower cost Scenario 4 plans do not include a new resource at Palo Seco until 2028. All scenarios include relatively high reserve margins, due in part to the "critical load" constraint,[931] and the Energy Bureau considers that this constraint may be excessive, as further discussed in Part III(I) of this Final Resolution and Order.

644. The Energy Bureau does **FIND** that five core elements of PREPA's ESM Scenario are reasonable and should be retained as part of a Modified Preferred Resource Plan and Modified Action Plan, because they contain elements common to all plans and have been indicated by PREPA to be "no regrets" actions. The five core elements are:

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930 *See* Proposed IRP, page 10-7, "Should the customer load or generation projects at other sites indicate an adjustment is warranted." PREPA response to the Energy Bureau's ROI 1, July 11, 2019, page 1-5(a) estimated the savings in fuel costs if a combined cycle at Palo Seco was not able to be developed. The same response to part (b) did not directly address the question of how increased battery storage or renewables could serve as a hedge against uncertainties.

931 *See* Proposed IRP, Appendix 1, page 2-6.

1. Timely conversion of older steam plant infrastructure to synchronous condensers providing dynamic reactive support, and stability and inertial characteristics for PREPA's system after installation of increased quantities of solar PV.
2. EE deployment, to the maximum amount obtainable as seen in "Full EE" Scenarios.
3. Maximum procurement of solar PV in line with all Scenarios.
4. Battery energy storage as an element of a Modified Preferred Resource Plan.
5. Hardening of T&D (discussed further Part III(I) of this Final Resolution and Order).

f. Virtual power plants as option for PV and BESS resource development

645. VPPs are essentially distributed resources which in total equate to a supply resource that can take the place of conventional, centrally located power plants, while also potentially providing distributed resiliency. Sunrun's witness Mr. Rauscher defined VPPs as consisting of "a fleet of distributed assets that can be monitored and managed as a dispatchable resource at multiple levels of aggregation which will support mini-/micro-grid architecture".[932] PREPA's modeling results that call for increased levels of solar PV and battery energy storage resources do not distinguish between requiring solar PV and battery storage resources at utility scale, versus requiring them at distributed scale.[933] PREPA's inclusion of a fixed trajectory of distributed resources as part of its input assumptions[934] does not preclude additional distributed resources to meet the levels required from the Scenario modeling results. PREPA directly acknowledges and accepts that VPPs can provide the services required – energy and capacity provision – and is supportive of competitive solicitations that would seek to procure this resource.[935]

646. The Energy Bureau **FINDS** that PREPA's modeling results that include substantial needs for new solar PV and battery resources in the near and longer-term for Puerto Rico fully supports competitive procurement of these resources from among both utility-scale, and smaller, distributed scale VPPs,[936] as long as technical specifications are met, are reasonable.[937] The Energy Bureau's Modified Action Plan sets out processes to ensure reasonable procurement processes for VPPs.

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[932] Sunrun, Direct Testimony of Christopher Rauscher, October 23, 2019, page 5.

[933] Testimony of Christopher Rauscher and confirmation by Dr. Bacalao, concerning solar PV and storage could be a distributed resource. *See* Evidentiary Hearing, February 6, 2020, morning session, 02:26:49.

[934] *See* Proposed IRP, Appendix 4, Demand Side Resources, page 3-19.

[935] Testimony of José Ortiz and Dr. Bacalao. Evidentiary Hearing, February 7, 2020, morning session, 0:45.

[936] Testimony of Sunrun witness Christopher Rauscher. October 23, 2019, page 5.

[937] Testimony of Dr. Bacalao, Evidentiary Hearing, February 6, 2020, morning session, circa 02:26.

g. Gas-fired capacity additions – peaking resources

647. All peaking resources included in PREPA's Preferred Resource Plan are based on fixed decisions.[938] All of those fixed decisions rely on purported resource need under its MiniGrid construct,[939] whereby thermal resources are required to serve critical load.

648. The Energy Bureau **FINDS** that PREPA has not supported inclusion of roughly 400 MW[940] of new fossil-fuel peaking resources in a least cost plan, as no assessment of need for new peaking resources has been made beyond PREPA's use of its MiniGrid construct that increases the reserve requirement from thermal resources. The Resource Need Assessment indicates the potential for required battery energy storage resources to provide the PRM required.[941] The Energy Bureau **DISAPPROVES** PREPA's inclusion of all of these new peaking resources in a Preferred Resource Plan. The Energy Bureau **FINDS** that replacement of a small portion of the older GT resources with peaking resources, using competitive procurement processes and open to all technologies, is reasonable to provide local resource coverage supplementing the existing operating older GT units.[942] The Modified Action Plan will describe a process for procuring these resources.

h. Gas-fired capacity additions –new combined cycle resources

649. PREPA has not supported inclusion of a new gas-fired combined cycle unit at Palo Seco by 2025 in the least cost plan, as S3S2 does not include such a resource for any of five different modeled loading levels.[943] In contrast with the ESM Plan, which the Energy Bureau has rejected as a preferred resource plan and which does include a new combined cycle unit, Scenario 3, which does not call for a new thermal combined cycle unit at Palo Seco, still contains a high reserve margin (approaching 50% in 2025 and

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[938] PREPA's Response to the Energy Bureau's ROI 7-6 (a), (b), (c), September 12, 2019.

[939] Appendix 1, page 2-6; critical loads "must be served by thermal resources".

[940] The range of new peaking resources across all Scenarios is 348 MW to 513 MW, with key Scenarios S3S2B at 348 MW, S4S2B at 371 MW, and ESM (base) at 421MW.

[941] *See* Figure 4. Annual Net Position with S4S2 Level of Battery Additions and Figure 5. Annual Net Position with S3S2 Level of Battery Additions of the Resource Needs Assessment in Part III(D) of this Final Resolution and Order .

[942]Energy Bureau's ROI 9, December 6, 2019, 9-2, Attachment 1, indicates roughly half of the 18 older GT units are currently inoperable.

[943] Appendix C, Tables C-2, C-4, and C-5.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

exceeding it in all other years), in part because of the modeling requirement that dictates a need for thermal resources above a 30% minimum planning threshold.[944]

650. Even the need for a new thermal unit at Palo Seco in S4S2 or ESM is based in part on the resource need premise that critical load, as defined by PREPA, must be able to be served by thermal resources following an extreme storm event.[945] Under S4S2, a new CCGT in 2028 or 2025 is called for, depending on the specific loading scenario. Scenario S4S2B Low EE and No EE does not build a combined cycle unit at Palo Seco until 2028; Scenario S4S2B (Full EE) does call for such a unit by 2025[946].

651. The underlying construct, requiring thermal generation to support critical load, affects the modeling result that builds a new CC at Palo Seco in 2025 or 2028 under S4S2, and assumes a new CC at Palo Seco in 2025 as a fixed decision under the ESM Plan. However, under minimum threshold PRM requirements, planned installed battery resources by 2025 provide more than sufficient capacity.[947] When considering any additional replacement peaking capacity, such as is addressed above, the reserve margin increases even more than is shown in the Resource Need Assessment (Part III(D) of this Final Resolution and Order).

652. Load level uncertainties do not support a hedging need for the near term – higher load levels (No EE) call for the new CC in 2028, leaving a number of years before PREPA would need to commit to such a build, even if a higher reserve margin was adhered to. In response to the Energy Bureaus' ROI 1, PREPA described the source of its more generally claimed "hedging against uncertainties" as part of its rationale for new gas infrastructure associated with the ESM Scenario.[948] The response computed differences in NPV for Scenarios with different timelines implementing a new combined cycle gas-fired generator. It did not specifically address any alternative resource plans, for EE or renewable resource deployment, that could also be considered when hedging against uncertainties.

653. The Energy Bureau **FINDS** that PREPA has not supported inclusion of a new CC at Palo Seco by 2025 in a least cost plan. Under the S3S2B Scenario, for all levels of EE, a new CC at Palo Seco is not part of the plan. Under some of the results for Scenario 4, a new

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Table 1, Resource Needs Assessment, Scenarios 3, 4, and ESM for 2025.

945 *See* Proposed IRP, Appendix 1, pages 2-6. All Scenarios include a requirement that a portion of peak load must be met only by the thermal resources available to the model. The effect of this requirement is seen in the Resource Needs Assessment Part of this Final Resolution and Order, with reserve margins far in excess of 30% for all Scenario 3, 4 and ESM plans.

946 Energy Bureau's ROI 10, December 13, 2019, page 10-5, Table 3.

947 *See* Figure 4 and Figure 5 in the Resource Need Assessment in Part III (D)) of this Final Resolution and Order.

948 PREPA's Response to Energy Bureau's ROI 1, July 11, 2019, pages 1-5.

CC at Palo Seco is not required until 2028. Under other results for Scenario 4, the inclusion of a new CC by 2025 is at least in part an artifact of the requirement to have more thermal generation available to meet PREPA-defined "critical" loads, rather than to meet minimum planning reserve requirements. The Energy Bureau **FINDS** that excluding, at this time, the development of a new CC at Palo Seco by 2025 in this IRP cycle is aligned with reasonable planning, and a Modified Preferred Resource Plan, and **ORDERS** PREPA to cease any spending on the devlopment a new CC at Palo Seco at this time except as indicated in the following paragraphs for limited, preliminary permitting and engineering requirements.

654. PREPA has numerous means to ensure adherence to minimum reserve requirements in the absence of planning for a new CC at Palo Seco by 2025. Successfully procuring required utility-scale and/or distributed battery storage resources; successfully implementing demand-side management plans; and ultimately delaying final retirement decisions for existing older thermal generation if necessary are all reasonable resources to consider in advance of the next IRP planning cycle. However, to protect against the uncertainty of near-future solar PV and battery energy storage price outcomes, or other potential reliability concerns, out of an abundance of caution and coupled with strict oversight as detailed in the next three paragraphs, the Energy Bureau **AUTHORIZES** $5 million for preliminary siting, permitting, and planning analysis regarding a new combined cycle unit at Palo Seco.[949]

655. The Energy Bureau **LIMITS** preliminary permitting and engineering expenditures relative to the range of costs estimated by PREPA[950] in part as recognition of a different situation at Palo Seco where some LNG infrastructure already exists, and also to clearly indicate that the Energy Bureau expects PREPA to be cost efficient with any such expenditures. Thus the Energy Bureau **CAUTIONS** PREPA that it must be highly cost-efficient with any preliminary permitting and engineering activity it undertakes, and that these activities **SHALL NOT** interfere or delay the procurement of solar PV and battery energy resources as directed in the Modified Action Plan and described elsewhere in this Final Resolution and Order.

656. The Energy Bureau also **ORDERS** PREPA to submit quarterly reports, commencing no later than January 1, 2021 describing the work performed, the staffing or consultant resources used to complete the work, and the status of the overall preliminary efforts. If PREPA determines that additional funding in exceedance of the $5 million allocated is required, PREPA shall file a request for approval before the Energy Bureau for such

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[949] PREPA Supplemental Response in Compliance with April 28, 2020 Resolution and Order, May 1, 2020. PREPA indicated in this response that the cost range for preliminary permitting and front-end engineering design (FEED) for a new combined cycle unit and an LNG terminal at either of the locations at Mayagüez or Yabucoa was $6.5 million to $7.5 million.

[950] *Id.*

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

additional budget. The mentioned request shall provide substantiating data for such budget increase.

i. Modeling results summary – NPVRR + value of energy not served

657. PREPA's modeling results are also presented for each Scenario accounting for PREPA's computation of the value of deemed "energy not served" (ENS) under its MiniGrid construct.[951] "Energy not served" is a term used by PREPA to represent a quantity of load that would not be served in the case of a prescribed weather event that prevents delivery of power to a group of customers. PREPA compares different estimates of "energy not served" across Scenarios as way of estimating the relative "resiliency" value for a given Scenario, under its MiniGrid and local capacity resources construct. Table C-1 in Appendix C lists the ENS, and the NPVRR + ENS values from PREPA 's modeling. The summation of NPVRR and ENS is intended as an indication of the relative value of any given Scenario to provide system resiliency in the face of an extreme event that causes the broader Island transmission grid to be unavailable to serve local load. The extent to which this metric – PREPA's measure of the relative value of energy not served – should be considered when formulating a Preferred Resource Plan is addressed in our analysis of PREPA's MiniGrid construct. We do not directly weight this resiliency parameter when considering the modeling results of the Aurora LTCE tool, as all Aurora LTCE results are for the integrated system and do not reflect any loss-of-load considerations that might arise from an extreme storm event.

H. Caveats and Limitations

658. Section 2.03 (I) of Regulation 9021 requires that the IRP include an annotated list of key caveats and limitations of the analysis, in order to illustrate the level of certainty that exists with respect to the Preferred Resource Plan. The caveats and limitations list shall include the impact of uncertainty, the modeling mechanism, key regulatory and project execution assumptions, and costs.

1. PREPA Filing

659. PREPA notes that its analyses consider a large number of options and uncertainties, using formal and informal input from PREPA and stakeholders. PREPA presents a list of 24 specific caveats and limitations associated with its plan, in Part 9 of the Proposed IRP.[952]

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[951] PREPA explains its concept of "energy not served" in Section 2.15 of the Proposed IRP Appendix 1: Transmission and Distribution, at page 2-104 through 2-107. PREPA presents "energy not served" computations on the "production cost" tab of each Scenario's metrics file and in the filed workpaper "MiniGrid VOLL_Final.xls".

[952] *See* Proposed IRP, pages 9-1 to 9-5.

660. PREPA presents a list of 24 specific caveats and limitations associated with its plan, in Part 9 of the IRP.

2. Intervenors

661. All of the Intervenor testimonies address to some extent the effect of one or some of the caveats listed by PREPA, with the specific areas noted in each of the Intervenor Parts of this Final Resolution and Order. For example, caveat number thirteen (13) addresses renewable generation market pricing; testimony from Sunrun, LEOs, SESA-PR, Windmar Group, and EDF all contain information concerning market pricing of solar PV energy.

3. Discussion

662. A number of the caveats listed have particular bearing on the selection of a Preferred Resource Plan[953]:

- Caveat number thirteen (13) will affect the ultimate pricing seen for renewable energy sources procured by PREPA.
- Caveat number fourteen (14) concerning the pace of solar PV and storage project installation directly affects the assumptions used by PREPA to define different resource Scenarios.
- Caveat number fifteen (15) notes the new nature of utility scale storage projects, and indicates the presence of a "learning curve" for these projects.
- Caveat number sixteen (16) concerns the limitations PREPA considers when connecting solar PV or wind projects to the system, depending on the level of storage also interconnected and "corresponding"[954] to the renewable energy project. However, PREPA also notes[955] that flexibility will be given to bidders during the implementation phase of IRP resource procurement, allowing for bids for one or both components of solar PV and battery energy storage.
- Caveat number seventeen (17) concerns recommendations for the retirement of existing steam generation. It notes prerequisites to this retirement, including the presence of load reduction, new capacity, and existing capacity reliability.
- Caveat number eighteen (18) describes the presence of certain assumptions for capital costs and technical performance of generation resources including thermal resources and LNG terminals.

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953 *Id.*

954 *See* Proposed IRP, page 9-4.

955 *See* Proposed IRP, Minimum Technical Requirements, page 6-27.

- Caveats number twenty-two (22) and twenty-four (24) reference, respectively, the DG interconnection standard IEEE 1547-2018 and the fact that the Proposed IRP is not a distribution system master plan.

663. The parameters represented by the foregoing caveats will have a direct bearing on the overall economics of any given resource plan, as will some of the other caveats listed by PREPA. In this regard, the Energy Bureau **FINDS** that PREPA's inclusion of these caveats and limitations as part of the Proposed IRP is reasonable as it helps inform consideration of the Modified Preferred Resource Plan. While PREPA does not present any discussion of the overall level of certainty it has with respect to its Preferred Resource Plan in Part 9 of the Proposed IRP, PREPA does present such discussion in the Introduction and Summary of Conclusions section and in its Resource Plan Development section, Part 8 of the Proposed IRP.[956]

664. In the "score card" section of the Proposed IRP,[957] PREPA presents a "balanced score card" where PREPA characterizes its Preferred Resource Plan, the ESM Scenario, with color-coded weightings for different attributes of each plan.

665. However, PREPA provides no direct means of assessing the relative weights given to the color-coding assigned to each of the parameters, thus rendering the "overall" color assignment arbitrary. Under questioning at the Evidentiary Hearing, PREPA confirmed that one "shouldn't give too much weight to that scorecard"[958] when comparing results across Scenarios, as more specific metrics have been provided in the metrics files of the Proposed IRP. The Energy Bureau **FINDS** that PREPA's score card as presented in this Proposed IRP is not useful to compare the scenarios, and **ORDERS** PREPA to explicitly include specific quantitative weightings for any attribute, with accompanying explanation and rationale for any assigned weights, if PREPA chooses to use a score card in the next IRP.

I. Transmission and Distribution System

666. Regulation 9021[959] defines the requirements for Transmission and Distribution (T&D) System Documentation and Analysis. PREPA must provide narrative descriptions of the T&D systems, including transmission system constraints, and a high-level analysis of the ability of the transmission system to interconnect new generation and support energy interchange with microgrids and independent power production. PREPA must describe planned transmission facilities for the next ten years and document the

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[956] *See* Proposed IRP, pages 1-5 to 1-8; pages 8-10 to 8-15, and in individual resource scenarios sections in Part 8 of the Proposed IRP.

[957] *See* Proposed IRP, pages 8-13 to 8-15.

[958] Evidentiary Hearing, February 6, morning session, 03:32:30.

[959] *See* Regulation 9021, §§ 2.03 (J)(1) and (2).

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

implications on the T&D systems of a preferred resource plan. PREPA must also describe planned changes to its distribution system over the next ten years, including its ability to accommodate incremental penetration of DG.

1. PREPA Filing

a. Overview

667. PREPA describes its transmission system as consisting of approximately 1,115 miles of transmission lines at voltages of 230 kV and 115 kV; and 1,376 miles of sub-transmission lines at 38 kV.[960] The transmission system includes 100 miles of underground 115 and 38 kV lines, and 23 miles of sub-sea cables to Vieques and Culebra.[961] PREPA's 230 kV lines are looped to provide energy from generation located in the southern part of the island to serve load centers at the North of the island. The 115 kV transmission lines serve major load centers across the island. The 38 kV sub-transmission lines transfer energy from the transmission system and major generating station locations to the distribution system and ultimate customers. PREPA lists its seven "critical reliability and system security objectives, standards and design criteria" for its transmission system in Appendix 1.[962]

668. PREPA describes its distribution system as consisting of over 1,100 feeders at five different voltage levels, with most feeders rated at either 4.16 kV, 8.32 kV or 13.2 kV. The system contains over 5,000 miles of mainline feeder trunks, and 10,000 miles of additional feeder lines running off the main trunks. Most of the system is overhead, but underground branches exist in laterals off the main trunk lines. Over 250 substations across the Island are used to move energy from the transmission to the distribution system.[963]

669. PREPA presents its detailed T&D system documentation and analyses in Appendix 1 to the Proposed IRP (Appendix 1). Appendix 1 contains five sections: Introduction (Section 1); MiniGrid Analysis (Section 2); Integrated System Steady State Analysis (Section 3); Integrated System Stability Analysis (Section 4); and Distribution Analysis (Section 5). A publicly available redacted version of the MiniGrid Analysis section is provided as Exhibit 1.01C of the Proposed IRP. Much of PREPA's resource planning, including transmission planning, is based on its underlying MiniGrid construct,

[960] *See* Proposed IRP, Appendix 1, page 2-2.

[961] *Id.*

[962] *Id.*

[963] *See* Proposed IRP, Appendix 1, Distribution System Analysis, pages 5-1 to 5-3.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

whereby PREPA describes transmission hardening and local capacity resource investment leading to a resilient power system.[964]

670. PREPA describes its principal transmission recommendations and T&D investment plan in the Action Plan section of the Proposed IRP,[965] summarizing information presented in Appendix 1. PREPA does not include T&D spending in its summary of resource plan costs; and does not indicate any differences in T&D spending that could arise from different resource plan approaches.[966]

671. PREPA's proposed T&D investments, compiled in Table 14 below, are intended to bring existing facilities to current or new standards, harden existing facilities, build new facilities for its MiniGrid plan, support the integration of distributed energy resources (in particular, rooftop solar), ensure the resiliency of distribution supply, and provide new or upgraded T&D substations to support its proposed MiniGrid construct.[967] PREPA's MiniGrid construct categorizes investments as main backbone, backbone extension, interconnection of critical loads, interconnection of MiniGrids, and existing infrastructure hardening and replacement.[968] These investment categories are then subdivided into 115 kV and 38 kV investment categories. For both MiniGrid approaches and "Other Transmission" spending, the investments are also categorized by Project Type (line hardening/reconstruction; new line; new underground construction; switchyard hardening/reconstruction; and aging infrastructure replacement).[969]

672. As seen in Table 14 below, PREPA categorizes its proposed schedule of transmission investments into five groups: Priority 1 (2020-2022 in-service dates), Priority 2 (2023-2024 in-service dates), Priority 3 (2025-2026 in-service dates), Priority 4 (2027 in-service date), and Priority 5 (2028 in-service date). PREPA provides a confidential list of Priority 1 and 2 projects attached in Confidential Appendix B to the Proposed IRP. The Proposed IRP does not specifically describe the process that PREPA used to determine its prioritization other than PREPA took into consideration operation and

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[964] *See* Proposed IRP, page 1-8: "Central to the IRP is developing the capability to segregate the system into eight MiniGrids to improve the system resiliency. The MiniGrids require the recommended generation and battery energy storage projects described below and the recommended transmission and distribution additions (mostly underground facilities) and hardening projects described in Appendix 1."

[965] *See* Proposed IRP, Section 10.2, "Creating a Resilient Grid", pages 10-10 to 10-16, and Section 10.3, "Engaging the Customer: Distribution System, Energy Efficiency and Demand Response", pages 10-17 to 10-22.

[966] *Id.* at Exhibit 8-3: Summary of Results by Scenario, Strategy and Load Growth, page 8-8.

[967] *Id.* at pages 10-10 and 10-17.

[968] *Id.* at Exhibits 10-7 and 10-9.

[969] *Id*. at Appendix 1, Exhibits 2-85, 2-89, and 2-97.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

field related construction coordination.[970] PREPA does note that its proposed investment schedule is a high-level estimate and requires detailed planning.[971]

b. Transmission and distribution system proposed investments

Table 14. PREPA's Proposed Transmission and Distribution System Investments, $ Millions

Category	Priority 1 (2020-2022)	Priority 2 (2023-2024)	Priority 3 (2025-2026)	Priority 4 (2027)	Priority 5 (2028)	Total
Transmission						
Existing Infrastructure Hardening	$354	$408	$360	$449	$280	$1,851
Aging Infrastructure Replacement	$29	-	-	-	-	$29
Total – Reliability (non-MiniGrid)	$383	$408	$360	$449	$280	$1,880
MiniGrid- 115 kV	$2,048	$322	$214	$138	$86	$2,808
MiniGrid – 38 kV	$1,821	$619	$313	$205	$89	$3,047
Total MiniGrid	$3,868	$942	$526	$343	$176	$5,855
Total – Transmission	**$4,252**	**$1,350**	**$886**	**$792**	**$455**	**$7,735**
Distribution						
Distribution – Substations (GIS)	$81	$52	$22	$22		$177
Distribution – Feeders	$368	$215	$119	$33		$734
Total – Distribution	**$449**	**$267**	**$141**	**$55**		**$912**
Total T & D	**$4,701**	**$1,617**	**$1,027**	**$847**	**$455**	**$8,646**

Source: PREPA Exhibit 10-7, 10-9, 10-11, and 10-19. Note: GIS stands for gas-insulated substations.

673. The expenditures listed in Table 14 above are further detailed by regional location in the Proposed IRP,[972] and specific locations and infrastructure descriptions are provided in a confidential workpaper to Appendix 1.[973]

674. Proposed IRP Exhibit 10-7 summarizes PREPA's proposed MiniGrid 115 kV transmission investments. Over the period 2020-2028, PREPA proposes to spend $2.8 billion on its 115-kV transmission infrastructure. In the first five years (2020-2024),

[970] *Id.* at page 10-10.

[971] *Id.*

[972] Appendix 1, Exhibits 2-93 and 2-98, and as described at pages 2-98 to 2-104.

[973] MiniGrids CapEx Summary_wPriority_Final.xls, part of the Proposed IRP.

PREPA proposes to spend approximately $2.4 billion or 84% of the $2.8 billion for 115 kV MiniGrid investments.

675. Proposed IRP Exhibit 10-9 summarizes PREPA's proposed MiniGrid 38 kV transmission investments. Over the period 2020-2028, PREPA proposes to spend approximately $3.0 billion on its 38-kV transmission infrastructure. In the first five years (2020-2024), PREPA proposes to spend approximately $2.4 billion or 80% of the $3.0 billion for 38 kV MiniGrid investments.

676. Proposed IRP Exhibit 10-11 summarizes PREPA's proposed transmission reliability investments. Over the period 2020-2028, PREPA proposes to spend approximately $1.9 billion on its transmission reliability investments. In the first five years (2020-2024), PREPA proposes to spend approximately $791 million or 42% of the $1.9 billion for transmission reliability investments. Most of the investment would be for the hardening of existing infrastructure.

677. Proposed IRP Exhibit 10-19 summarizes PREPA's distribution related investments, which are described in Section 10.3.1 of the Proposed IRP.[974] PREPA proposes to spend an estimated $911 million on feeder and substation upgrades, with the bulk of the feeder work associated with undergrounding the mainlines of those feeders; and the substation work focused on upgrading to gas-insulated substations (GIS) equipment to better ensure "survivability from a major hurricane."[975]

678. PREPA identifies feeders potentially having issues with the interconnection of PV systems in the next five years,[976] and also conducted a high-level investigation of the possible impact of projected rooftop PV growth in the next five years.[977] While PREPA indicates that some of these feeders are candidates for voltage conversion to 13.2 kV to support DG, capital expenditures for such conversion are not included in the totals in the planned investment provided in Exhibit 10-19.[978] PREPA also notes that its distribution analyses "can only be used for screening purposes" and that more asset-based detailed analyses will be required in the future to implement the projects.[979]

679. As seen in Table 14 above, PREPA's total proposed T&D spending through 2028 amounts to $8.6 billion, with $6.3 billion proposed for the next five years. Of the $8.6 billion total, two-thirds of that investment ($5.9 billion) is associated with the MiniGrid construct. PREPA makes no assumptions on the extent to which Puerto Rico ratepayers

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[974] *Id.* at pages 10-17 to 10-20.

[975] *Id.* at page 10-17.

[976] *Id.* at page 10-20.

[977] *Id.* at page 10-18.

[978] *Id.* at page 10-18.

[979] *Id.* at page 10-19.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

will be directly exposed to transmission costs, and does not assume that FEMA will pay for all or a part of any investments; PREPA indicates that the investments are for reliability/resiliency reasons.[980]

c. Reliability analyses

680. Section 3 of Appendix 1 describes PREPA's Integrated System Steady State Analysis associated with different Scenarios. This subsection contains results that are focused on a system that includes "…all the new transmission upgrades or existing infrastructure enhancements modeled based on the transmission investment project information from PREPA".[981] PREPA conducts contingency modeling to assess the reliability of the transmission system under day and night peak conditions, focusing on ESM, Scenario 1 and Scenario 4 conditions, but also including Scenario 3 and Scenario 5 conditions.[982] PREPA found no major reliability violations in any of these analyses.[983] PREPA also conducts analyses for "weakened system"[984] and for the existing system without any new transmission system reinforcements.[985] PREPA found no major transmission system concerns under the weakened system analysis, and resolved concerns associated with its existing system analysis.[986]

681. PREPA analyzes generation interconnection under different scenarios inclusive of new thermal generation, small peaker generation, and solar PV and battery energy storage interconnection.[987] PREPA generally indicates minimal or no concerns with transmission system reliability for any of the large or small thermal unit interconnections, and indicates no reliability violation concerns under preliminary assumptions associated with solar PV and battery installation.[988] PREPA also notes little or no transmission congestion across its future Scenarios as modeled in its "nodal scenarios",[989] although PREPA does indicate some dependency on eventual location of

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[980] PREPA Response to Energy Bureau's ROI 2-6 (b), July 18, 2019.

[981] *See* Proposed IRP, Appendix 1, page 3-1.

[982]*Id.*

[983] *Id.*

[984] Appendix 1, pages 3-11 to 3-12. A weakened system represents the loss of some transmission elements after a major storm.

[985] *Id.* at page 3-13.

[986] *Id.* at pages 3-13 and 3-14.

[987] *Id.* at pages 3-14 to 3-15.

[988] *Id.* at page 3-15.

[989] PREPA modeled selected scenarios in 2025 and 2028 to analyze transmission system congestion using a more granular modeling approach that included all transmission nodes in Puerto Rico. *See* Workpaper "Aurora Method and Hourly Dispatch Assessment.docx" filed Jun 14, 2019.

solar PV affecting congestion for one Scenario.[990] PREPA notes that when specific locations and actual capacity are known for solar PV and battery locations, full interconnection studies will be needed.[991]

682. Section 4 of Appendix 1 presents PREPA's analysis of dynamic performance of its transmission system.[992] Its most important finding is that while the system is generally stable, conversion of retiring generation to synchronous condenser operation to prevent voltage instability will be required.[993] PREPA also recommends specific configuration characteristics for new battery resources, to allow voltage and frequency response performance to maintain a stable grid.[994]

d. Distribution system analysis including distributed generation increases

683. Section 5 of Appendix 1 contains PREPA's distribution system analysis, providing additional detail for distribution system analyses first presented in the Action Plan of the Proposed IRP.[995] It describes the overall characteristics, design, and performance of the distribution system.

684. Section 5.3 of Appendix 1 describes the impact of DG on the system, including identification of a limited number of feeders whose existing technical capabilities would potentially be of concern for integration of DG. PREPA describes solutions across three areas: 1) voltage upgrades and better voltage control across the system; 2) feeder upgrades to protect against overloads with DG; and 3) reverse power flow mitigation through protection system upgrades.[996] While PREPA states that "several technical conditions"[997] limit its capability to integrate DG, the information that follows indicates that such limitations are applicable to a subset, but not all, of its feeders.[998] PREPA states in its Proposed IRP Action Plan that more thorough distribution system analyses are required.[999] PREPA also notes overall concerns with its distribution system, beyond

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[990] PREPA's Response to Energy Bureau's ROI 1-53 (d), July 11, 2019.

[991] *Id.*

[992] Dynamic performance is the assessment of how the transmission system responds to a disturbance; it is generally focused on the ability of the system to maintain reliable voltage and frequency characteristics resulting in stable operation of the entire system.

[993] Appendix 1, page 4-1.

[994] *Id.* at page 4-59.

[995] *See* Proposed IRP, pages 10-17 to 10-22.

[996] Protection systems concern the relaying and related controls at substations where feeders begin. *See* Proposed IRP, Appendix 1, pages 5-10 to 5-11.

[997] *Id.* at page 5-10.

[998] *Id.* at page 5-12.

[999] *See* Proposed IRP, page 10-19.

those issues that impact DG integration, including the presence of five different primary voltages across its system.[1000]

685. Section 5.4 of Appendix 1 contains the details of PREPA's proposed distribution system investments for resiliency, which are summarized in the IRP Action Plan.[1001] PREPA recommends the undergrounding of feeder mainlines or trunklines, and the conversion of air-insulated substations to gas-insulated substations to better protect these assets from outages associated with storm events. PREPA describes the distribution system investments as a required "parallel effort"[1002] to that of the MiniGrid construct at the transmission system level. PREPA notes that its distribution system resiliency screening contained in the Proposed IRP does not include a thorough on-site assessment, and while it lists priority feeders and substations for resiliency investment, it notes that "the priority order and actual investments may be modified considerably."[1003]

e. MiniGrid construct as proposed in the IRP

686. Appendix 1 and PREPA Workpapers[1004] contain the details of PREPA's proposed MiniGrid construct for the transmission system, which is designed to establish greater system resiliency in the face of major storms.[1005] Appendix 1 is Confidential, nevertheless, a redacted version of Section 2, which contains the MiniGrid analysis[1006] is available as Exhibit 1.01C.[1007]

687. Under all of the Proposed IRP Resource Scenarios and Strategies, PREPA models the Puerto Rico electric system as a set of MiniGrids whose boundaries reflect specific districts in the Commonwealth (similar to PREPA's administrative organization). According to PREPA, this "district" basis helps to facilitate operations and repair,[1008] and reflects as "…the main driver [the] exposure of the overhead transmission lines to an

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1000 Appendix 1, page 5-2.

1001 *See* Proposed IRP, Action Plan, Section 10-3, pages 10-17 through 10-21.

1002 Appendix 1, Section 5.4.

1003 *Id.*

1004 "MiniGrids CapEx Summary_wPriority_Final.xlsx" and "IRP_19_Substation_LoadProcessing_Final.xlsx" (the "MiniGrid Workpapers") which contain capital expenditure costs and load calculations used in the Proposed IRP.

1005 Appendix 1, pages 2-1 through 2-4.

1006 *Id.* at Section 2, "Transmission System – MiniGrid Analysis".

1007 *See* IRP2019 EX 1.01C Appendix 1_Section2_Redacted.pdf.

1008 Appendix 1, page 2-4, "Keeping district boundaries, however, should facilitate the operation and repairs of the MiniGrids in the event of isolation".

extended outage."[1009] Each MiniGrid region is constrained in the resource modeling "to ensure that the MiniGrid will have local resources adequate to serve its load in isolation…".[1010] The eight MiniGrid regions, as defined by PREPA, are:

- San Juan-Bayamón
- Carolina
- Caguas
- Cayey
- Mayagüez North
- Mayagüez South
- Arecibo
- Ponce (East and West)

688. PREPA's MiniGrid construct envisions significant investment in 115 kV and 38 kV transmission infrastructure—$5.9 billion total[1011]—and additional distribution system investment of more than $900 million.[1012] PREPA assumes as part of the MiniGrid construct that substantial new transmission infrastructure is needed to ensure availability of power subsequent to a major storm event. The MiniGrid transmission investment components include "backbone" transmission hardening (e.g., undergrounding of 115 kV lines) and extensions to backbones, critical load interconnections, and substation hardening.

689. PREPA defines the critical load to be served in each MiniGrid region to include all feeder load for any feeder which contains actual critical load.[1013] This equates to forty-four percent (44%) of PREPA's forecast peak load, and includes both actual critical load and some priority load.[1014] PREPA uses seventy-five (75%" of the critical load peak for the determination of "thermal generation needs",[1015] and PREPA states that by definition in the MiniGrids "critical loads must be served by thermal resources only ensuring full

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[1009] *Id.* at page 2-4.

[1010] *Id.*

[1011] *See* Table 14 above and Appendix 1, Exhibit 2-93.

[1012] *See* Table 14 above and Proposed IRP, Exhibit 10-19, page 10-20.

[1013] Actual critical load is stated to include hospitals, police stations, fire stations, airports and piers, schools used as refuge during emergencies, telecommunications towers, nursing homes, emergency management and operations centers, Puerto Rico Aqueduct and Sewer Authority (PRASA) infrastructure, PREPA technical district infrastructure, town halls with services, and some commercial centers. PREPA response to Energy Bureau-PREPA Requirements of Information 2-9 and 4-12.

[1014] Appendix 1, Exhibit 2-2 and pages 2-4 to 2-5.

[1015] *Id.* at page 2-5.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

coverage right after the event and before the renewable generation (PV) and BESS are back online".[1016] The T&D infrastructure in PREPA's MiniGrid design are based upon maintaining continued supply to critical load feeders.

690. PREPA proposes that each of the eight MiniGrid regions contain sufficient capacity and energy resources to meet most of the local demand within the region when a major event occurs, leading to an ability to "serve its load in isolation".[1017] This is the critical load service noted above. PREPA resource modeling directly includes this critical load service constraint, and excludes any ability for adjacent MiniGrid regions to provide local capacity support for critical load in the event of a major storm.[1018] As seen in Table 15 below, this results in high PRMs relative to the thirty percent (30%) island-wide threshold[1019] required for reliability.

Table 15. PREPA Island-Wide Planning Reserve Margins

Scenario	2019	2020	2025	2030	2035	2036	2037	2038
S4S2B	71%	53%	69%	48%	67%	70%	74%	69%
S3S2B	86%	70%	48%	82%	99%	114%	130%	133%
S1S2B	68%	40%	49%	44%	45%	37%	40%	52%
ESM	71%	53%	78%	78%	97%	95%	100%	95%
MinThresh30%	30%	30%	30%	30%	30%	30%	30%	30%
_50%	50%	50%	50%	50%	50%	50%	50%	50%

Source: PREPA's Response to Energy Bureau's ROI 1-7, Attachment 1.

691. PREPA states that "the business case for transforming the grid architecture [with MiniGrids] is straightforward: it provides the least cost approach to achieve resilience against major hurricanes, meets and exceeds compliance with the renewable portfolio standard, engages customers, and lowers cost."[1020] PREPA provides analysis in Section 2.15 of its Appendix 1 of the VOLL in order to address its understanding of "whether this design provides an optimal balance between ratepayer costs and improved reliability".[1021] PREPA concludes that ""the total Value of Load Loss for any severe weather event that caused the transmission lines outages for a few weeks would be

[1016] *Id.* at page 2-6.

[1017] Appendix 1, page 2-4.

[1018] PREPA Response to Energy Bureau's ROI, 2-7, August 8, 2020 and ROI 4-12 a), August 23, 2020.

[1019] *See* Proposed IRP, page 8-89.

[1020] *Id. at* page 1-8.

[1021] Appendix 1, page 2-104.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

more than enough to justify the total cost of the proposed MiniGrid CapEx and would possibly take one major event to justify all investments".[1022]

f. Value of lost load

692. In Section 7.3 of the Proposed IRP and in Section 2.15 of Appendix 1, PREPA provides a description of the two methodologies used to determine the VOLL. PREPA also provides an estimate of the VOLL. VOLL calculates the value of load that would be served but for the effects of an outage such as seen during extreme events (e. g. hurricanes, earthquakes). Generally, VOLL represents a customer's willingness to pay for reliable electricity service. VOLL analyses incorporate, but are not limited to, the type of customer, demographics, regional economic conditions, time and duration of the outage, and seasonality of the outage. PREPA's use of the VOLL was to value the impact of the loss of local or system-wide supply across the IRP modeling scenarios of a Category 1 hurricane that would result in the loss of service for one month, and the impact of a Category 4 hurricane that would require the operation of each MiniGrid for one month.[1023]

693. Exhibit 7-15 of the Proposed IRP highlights methodologies used to estimate VOLL. PREPA notes that Commercial and Industrial customers typically have the highest VOLLs ($3,000 to $53,907/MWh) and that residential customers typically have the lowest VOLLs, in the range of $1,000 to $4,000/MWh.[1024] The range of estimated VOLLs is reflected in PREPA's summary of nine VOLL studies summarized in Exhibit 7-16.[1025] PREPA notes that longer duration outages result in higher VOLLs as the cost of the outage increases over time (due to the loss of wages, and loss of perishable goods).[1026]

694. For the purposes of the IRP, PREPA's first approach to quantify VOLL is based on a comparative analysis of the nine jurisdictional studies in Exhibit 7-16 based on PREPA's economic and demographic characteristics, electricity consumption patterns, market design, and customer distribution. PREPA concludes that its system is more closely aligned to a VOLL study for New Zealand, as shown in Exhibit 7-17.[1027] This comparative study results in a system wide VOLL of $31,897/MWh.

695. PREPA's second methodological approach utilizes the Lawrence Berkeley National Laboratory and Nexant's Interruption Cost Estimate (ICE) calculator that provides an

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[1022] *Id.* at page 2-106.

[1023] *See* Proposed IRP, page 7-32.

[1024] *Id*. at page 7-34.

[1025] *See* Proposed IRP, page 7-35.

[1026] *Id.* at page 7-35.

[1027] *Id.* at page 7-36.

estimate of the economic cost associated with system interruptions.[1028] PREPA's analysis incorporated historical (FY2016-FY2017) reliability indices (System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI), and Customer Average Interruption Duration Index (CAIDI)).[1029] PREPA's summary of the ICE calculator inputs are presented in Exhibit 7-20 of the Proposed IRP. These included customer usage by class, number of customers by class, industry composition, FY2016-FY2017 household income, power interruption distribution, and percent of back-up generation. The second methodology results in a system wide VOLL of $57,940/MWh. Both methods are dominated by the cost of unserved energy to medium and large Commercial and Industrial customers.

696. PREPA concludes that the first (literature-review-based) approach provided a more reasonable proxy for VOLL than the second approach, because the medium and large Commercial and Industrial VOLLs values of the second approach resulted in values out of the range of recent literature studies.[1030]

2. Intervenors

a. Local environmental organizations

697. LEOs' Dr. Irizarry-Rivera testified to the opportunities that residential solar PV and battery storage could provide in support of resiliency aims for the Commonwealth.[1031] Dr. Irizarry Rivera proposes a plan for "distributed resiliency" that would utilize residential rooftop solar PV and battery storage systems.[1032]

698. Mr. Sandoval, expert witness for the LEOs, describes an alternative (to the MiniGrid approach) strategy to ensure provision of critical services across Puerto Rico using microgrids with distributed energy resources to achieve site-level resiliency.[1033] Mr. Sandoval's testimony describes the PREPA requirement that deemed critical loads exclusively be served by dispatchable thermal resources as "arbitrary." Mr. Sandoval references the Sandia National Laboratory study on consideration of a microgrid infrastructure for Puerto Rico.

> Ultimately, Sandia's study identifies a sound approach to understand how resiliency can be defined, measured, addressed in a targeted

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[1028] Department of Energy, *Interruption Cost Estimate Calculator*, https://icecalculator.com/home.

[1029] *See* Proposed IRP, page 7-38.

[1030] *See* Proposed IRP, page 7-39.

[1031] LEOs, Direct Testimony of Prof. Agustín Irizarry Rivera, October 23, 2019, page 6.

[1032] *Id.* at page 27.

[1033] LEOs, Direct Testimony of Ronny Sandoval, October 23, 2019, page 12.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

manner, while recognizing local community impacts and a role for distributed generation.[1034]

699. While not providing the full study, which is a publicly available document,[1035] Mr. Sandoval noted that the Sandia report showed that a microgrid-based system with 159 "resilience nodes" would cost between $1.2 and $2 billion, and that a smaller scale version with a "large cluster" of portfolios would achieve "benefits close to the 'do everything' scenario" at a cost on the order of $300-$400 million".[1036]

b. Not-for-profit intervenors

700. Mr. Eric Ackerman testifies for the NFPs. He recommends that PREPA incorporate "Advanced Grid Planning" methods, or integrated distributed system planning, into its strategies.[1037] He notes that such planning directly evaluates hosting capacity for distributed generation integration, and can result in deploying DG resources "where they are needed, when they are needed,…" and that it will allow for "PREPA and/or third parties to optimize the design of distributed energy applications (*e.g.*, microgrids/MiniGrids developed for increased reliability and resilience on critical loads)."[1038]

701. Mr. Ackerman recommends PREPA re-examine its need for natural gas resources and testifies that "there is no factual basis" for its assumption that critical load be served by thermal resources only.[1039]

702. He recommends that PREPA compensate DG providers for demonstrated grid support from DG resources, including compensation for energy, capacity, and ancillary services,

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[1034] *Id.* at page 16.

[1035] The Energy Bureau references this document in its Draft Energy Storage Study, and Mr. Sandoval cites the full study: Jeffers, Robert Fredric, Andrea Staid, Michael J. Baca, Frank M. Currie, William Ernest Fogleman, Sean DeRosa, Amanda Wachtel, and Alexander V. Outkin. Analysis of Microgrid Locations Benefitting Community Resilience for Puerto Rico. No. SAND2018-11145. Sandia National Lab. (SNL-NM), Albuquerque, NM (United States), 2018. The study identified 159 potential microgrids to serve the critical infrastructure throughout the island with an estimated 343 MW of critical loads and 399 MW of non-critical loads. Sandia identifies four microgrid portfolios with varying ratios of thermal, photovoltaic, and battery resources, which cost in the range of $218-$917M. The report describes strategies and technologies that can be employed in microgrids such that not all feeder level loads are served, including the installation of distributed energy resources like solar photovoltaic and battery systems at the level of partial distribution feeders, on campuses, or behind the meter of individual buildings. The Sandia microgrid approach uses switches installed on feeders or partial feeders to shed non-critical loads in order to avoid oversizing infrastructure.

[1036] LEOs, Direct Testimony of Mr. Ronny Sandoval, October 23, 2019, pages 15-16.

[1037] NFPs, Direct Testimony Mr. Eric Ackerman, October 23, 2019, page 12.

[1038] *Id.* at pages 13-14.

[1039] *Id.* at page 19.

and for avoiding losses and transmission capacity. He states that using Advanced Grid Planning methods will help to "enable prosumers" in providing these services.[1040]

703. Mr. Ackerman testifies that PREPA's plan contains too much natural gas, and he states:

> Once these gas facilities are built, they are not likely to be displaced by renewable sources. To comply with Act 17, PREPA should build fewer natural gas facilities, and instead be more creative in designing MiniGrids that integrate renewable sources (i.e., photovoltaics, wind, and hydro), and batteries. Certainly, there is precedent for this kind of innovation. The Bronzeville micro grid being built by Commonwealth Edison Company to support critical loads in Chicago is being configured with PV, battery storage, and diesel generators. The Potsdam microgrid being planned by National Grid would integrate hydro generation, PV, batteries, electric vehicles, diesel generators, and combined heat and power systems. PREPA's successor should engage a state of the art microgrid design firm (e.g., Pareto Energy, Washington, D.C.; Willdan Group; or others) to explore MiniGrid designs that make maximum use of renewable resources. After PREPA has examined the opportunities to develop micro/mini-grids using renewable sources, it should re-evaluate its need for thermal generation.[1041]

704. Mr. Ackerman also notes the importance of strategies to comply with Act 17's requirement to reduce or contain rates. He states:

> Q. How can the June 7 Plan be revised to comply with Act 17's requirement to develop a strategy for reducing rates to below $0.20/kWh?
>
> A. PREPA needs to be more aggressive in reducing cost. The introduction of advanced grid planning methods will give PREPA, its successor, and the PREB a way to manage grid investments efficiently. PREPA needs to reconsider its approach to MiniGrids. In addition to discarding its unreasonable insistence on the exclusive use of thermal generation to serve critical loads (above), PREPA should adopt a more balanced approach to investments in transmission versus distribution. …[1042]

705. As part of Mr. Ackerman's overall conclusions, he emphasizes his recommendation for advanced grid planning methods, and that PREPA should revise its approach to

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[1040] *Id.* at pages 17-19.

[1041] *Id.* at pages 19-20.

[1042] *Id.* at page 22.

MiniGrid design and make only minimal investment in natural gas fired infrastructure. For compliance with Act 17, he notes the importance of continuing Energy Bureau oversight.[1043]

706. Dr. Woychik testifies for the NFPs. He notes the importance of properly integrating and optimizing resources to avoid stranded costs, as he notes that the costs of renewable and distributed resources are declining rapidly. Concerning the value of distributed resources, he states the importance of not committing to resource solutions that result in foreclosure of higher value and more flexible resource options.[1044]

c. Solar and Energy Storage Association of Puerto Rico

707. Mr. Wilson testifies on behalf of SESA-PR. He states that the distributed resource projections used in the Proposed IRP are not sophisticated enough, and notes that different factors – Act 17, block grant funding for DG, continuing cost reductions, availability of aggregated generation and storage, financing options, the impact of Hurricane María on availability and deployment of batteries, and market seller options – will lead to increases in the level of DG deployed in Puerto Rico.[1045] He recommends a deeper analysis of all scales of solar and storage deployment in Puerto Rico, so as to not violate the spirit of Act 17.[1046]

d. Sunrun

708. Sunrun's testimony by Mr. Chris Rauscher focused on the ability and cost-effectiveness of VPPs, which are aggregations of solar PV and battery storage combinations at individual sites, to provide distributed energy and capacity services, including resiliency.[1047] Sunrun notes the importance of considering the potential avoided T&D cost, when considering the resiliency value of VPPs, in addition to their provision of capacity and energy.[1048]

1043 *Id.* at page 24.

1044 NFPs, Direct Testimony of Dr. Eric Woychik, October 23, 2019, page 5, "… avoid early closure of the problem-solving space, enable openness to collaborative solutions…" and at page 6, "flexible, shorter-life, DERs configured in optimal packages can be used for a set of purposes over time and can be adapted to meet new needs as circumstances change."

1045 SESA-PR, Direct Testimony of Mr. Patrick J. Wilson, October 23, 2019, pages 15-16.

1046 *Id.* at page 19.

1047 Sunrun, Direct Testimony of Mr. Chris Rauscher, October 23, 2019, pages 3-9.

1048 *Id.*

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

3. Amicus Curiae

a. Rocky Mountain Institute

709. In its *Amicus Curiae* Brief, RMI performed an initial analysis of the capability of distributed solar and energy storage to meet the electricity demand of 20,000 critical facilities across the island, powering loads during a grid failure. The results of this review suggest that 650-700 MW of solar generation and 900-1,000 MWh of battery storage would be adequate to ensure resiliency. The filing suggests that the identified portfolio of alternate resources would have the potential to offset substantial costs to PREPA ratepayers.

710. RMI's Amicus Brief notes that PREPA's assumption that solar PV will be unavailable after a natural disaster is overly conservative and drives increased investment in fossil fuel resources. RMI states that it has identified specific practices for ground mount photovoltaic systems that can lead to projects that are rated for Category 5 hurricanes and estimates that implementing these recommendations would lead to a 5-8% increase in engineering, procurement, and construction (EPC) costs.

4. Discussion

711. The Energy Bureau's analytical and regulatory focus for T&D issues includes two elements: first, a specific assessment of PREPA's MiniGrid construct; and second, determining if and how PREPA's T&D system plans generally meet Regulation 9021 in the context of resource planning and Puerto Rico's need for a more resilient power system. As part of both the assessment of the MiniGrid construct and the reliable energy delivery aspects of the T&D grid, the Energy Bureau recognizes PREPA's inclusion of microgrid considerations in its IRP.[1049] The Energy Bureau also directly considers Act 17-2019 requirements that the promotion of microgrids be part of electric system resource planning.[1050]

a. Microgrids

712. PREPA includes a discussion of "Microgrid Considerations" in the Proposed IRP.[1051] Act 133-2016 and the Energy Bureau's regulation defines microgrids as a "group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected

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[1049] Appendix 1, page 2-8.

[1050] *See* Act 17, §1.5 (8) (c) and § 1.9 (3)(K).

[1051] Appendix 1, Section 2.3.4, page 8.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

or island-mode."[1052] The Energy Bureau's regulations on microgrid development[1053] sets the legal and regulatory framework required to promote and encourage the development of microgrid systems in Puerto Rico, enable customer choice and control over their electric service, increase system resiliency, foster EE and environmentally sustainable initiatives and spur economic growth by creating a new and emerging market for microgrid services.

713. Act 17 strives to promote microgrids[1054] in the course of resource planning for the electric power system. The Energy Bureau seeks to ensure PREPA compliance with Act 17, including promotion of microgrid use with decentralized energy resources containing those identified as sustainable renewable or alternative renewable energy resources, as defined by Act 82; combined heat-and-power; and other distributed resources, to strengthen the resiliency of the electric grid, empower customers, and increase reliance on renewable and highly-efficient resources across the Island.

714. PREPA notes that microgrids are the "best option" in areas where it would be "impractical or excessively costly" to maintain conventional supply.[1055] A microgrid strategy whereby critical, and potentially priority loads are met with distributed solar and battery systems, offers a viable approach to system resilience. Such a strategy aligns with Act 17 goals to reduce reliance on fossil fuels, to ensure the integration of renewable energy, and to encourage the use of energy storage technology as a DG mechanism.

715. PREPA in the Proposed IRP has not fully evaluated the extent to which a microgrid-based approach to resilience could be used to deploy at least a portion of the battery storage and solar photovoltaic assets identified as "no regrets" resources in all of the Proposed IRP Scenarios. These resources could serve a portion of Puerto Rico's energy needs during normal operating conditions in addition to meeting a portion of critical and priority loads during an emergency event. This approach could leverage planned investment in battery storage and solar PV systems, without incurring significant new costs and potentially avoiding some portion of investments in MiniGrid-related transmission and new thermal generation.

716. The Energy Bureau **FINDS** that microgrids form a critical part of the resiliency solutions envisioned for the Commonwealth. The Energy Bureau **ORDERS** PREPA to directly incorporate promotion of microgrid resources into all of its transmission, distribution,

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[1052] *See* Act 133-2016; Regulation 9028 § 108(B)(25)

[1053] *See* Regulation 9028 §§ 1.02-1.03.

[1054] For example, Act 17 Preamble: "facilitate the interconnection of distributed generation systems and microgrids,"; and Section 1.5 8) c) "To promote the development of microgrids, particularly in essential service facilities as these are defined in Act No. 57-2014, and in remote areas, as a mechanism to promote the resilience and modernization of the distribution networks;".

[1055] Appendix 1, page 2-8.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

and resource planning exercises and all deployment actions taken in compliance with the modified Action Plan described by the Energy Bureau in this Final Resolution and Order. This includes facilitating timely and non-discriminatory access for all DG and microgrid facilities to interconnect with PREPA's grid.

b. MiniGrid construct

717. PREPA's resource planning preference is founded[1056] on the MiniGrid construct, which combines intensive investment in transmission system hardening, parallel efforts to harden distribution feeder mainlines, and additional investment in local capacity resources to meet load needs when a hurricane or storm event leads to a complete severing of the transmission system across Puerto Rico, into eight "MiniGrids". This approach would cost $5.9 billion for the MiniGrid portion of the transmission system alone,[1057] plus hundreds of millions[1058] in investment for capacity resources to provide planning reserves far above (see Table 15, above) the Island-wide requirement of approximately thirty percent (30%) PRM. Existing transmission system hardening and aging infrastructure replacement add another $2 billion in transmission costs. Distribution costs exceeding $900 million are also required to complete the resilient delivery system, although even in the absence of the MiniGrid construct, PREPA will need to invest in the ability of the distribution system to support DG, and improve resiliency of supply.[1059]

718. PREPA's overall approach includes both extensive hardening of the transmission grid, including new "MiniGrid backbone" expenditures,[1060] and connections between MiniGrid areas,[1061] and simultaneously the provision of local capacity and energy resources (thermal)[1062] to meet as-defined critical load[1063] after a storm event. PREPA's

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[1056] *See* Proposed IRP, page 10-10. "The MiniGrid architecture is the foundation for the future of Puerto Rico's electrical system".

[1057] Appendix 1, Exhibit 2-93.

[1058] Additional new peaking resources alone would cost $433 million (IRP, Exhibit 10-6, page 10-9) and would increase the PRM above threshold levels that meet or exceed 30% when only considering battery resource additions, which are required in all Scenarios to support storage requirements for solar PV necessary to meet RPS.

[1059] *See* Proposed IRP, page 10-17.

[1060] Appendix 1, Exhibit 2-87. The MiniGrid Main Backbone is estimated at $2.1 billion.

[1061] Appendix 1, page 2-7. "Extension of the MiniGrid backbone to create high reliability and resiliency zones; most of these investments allow the interconnection of MiniGrids to form a larger MiniGrid allowing consolidation; but could be extensions to areas that otherwise would have to be a microgrid". See also PREPA response to Energy Bureau-PREPA ROI 1-6 d).

[1062]Local resources include both thermal and solar PV and battery resources, but PREPA's modeling first assumes that all critical load in the MiniGrid area is served by thermal resources.

[1063] As noted, PREPA's critical load definition includes all load on a feeder which contains critical load facilities.

approach also assumes that all eight MiniGrid regions are disconnected from each other, essentially providing no sharing of any reserve capacity, even though sizable expenditures are proposed to harden both the main 115 kV backbone and the interconnections between regions. PREPA assumes that even "hardened for reliability"[1064] transmission, not associated with establishing a MiniGrid, would not be back in service for a week after a storm event and thus is not available to support energy transfers between MiniGrid regions.[1065]

719. This multi-pronged planning approach is ripe for optimization. PREPA has not attempted to optimize transmission and energy and capacity resource spending. PREPA plans spending for MiniGrid transmission infrastructure ($5.9 billion), existing transmission infrastructure ($2 billion), hardening of distribution assets for resiliency ($911 million) and local, MiniGrid region capacity and energy resources (including existing and potential new customer-provided capacity and energy resources) whose total costs are difficult to untangle from the entirety of energy and capacity provision seen in the modeling results. PREPA proposes a plan that includes spending across all of these categories, without providing a means to test which combinations may be the least cost for customers.

720. To better address the level of transmission spending which would be optimal, including consideration of resiliency approaches that directly include all local energy and capacity resources, the Energy Bureau will initiate a new proceeding to consider these issues as further described in the Action Plan Part of this Final Resolution and Order.

i. Critical load served only by thermal resources as part of MiniGrid construct

721. PREPA states that thermal resources are needed within MiniGrid regions to meet critical load after a hurricane or major storm event.[1066] However, PREPA notes that, "(i)n as much as other resources can match this expectation [they] can be considered also to supply the critical load."[1067] The "expectation" in this instance is PREPA's assumption that 100% of the defined critical load would be met immediately upon separation of the MiniGrid region from the rest of the grid, in the event of a major storm. PREPA also notes that they did not conduct any studies to determine if "…distributed resources [can] supply critical load. In as much as those resources can comply with the criteria stated above, [they] can also be considered."[1068]

[1064] Appendix 1, Exhibit 2-97.

[1065] PREPA's Response to the Energy Bureau's ROI 2-7, July 18, 2019.

[1066] Appendix 1, page 2-6.

[1067] PREPA's Response to NFPs' ROI 1-2, September 11, 2019.

[1068] *Id.*

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

722. PREPA stated that it "…is open to configuring MiniGrids with customer-owned or community-owned generation … PREPA could incorporate customer and/or community-owned generation as part of the internal resources to supply the critical and priority loads."[1069] Intervenors indicated that distributed solar PV and battery resources could serve to provide energy to critical load.[1070] PREPA provides no analysis of the effect on the responsiveness or resiliency of its system under circumstances where distributed solar PV and battery resources did provide some of the restoration to critical load needs; instead PREPA's plan includes the entirety of the MiniGrid construct .

723. PREPA acknowledged that its definition of "critical load" at 44% of total peak load[1071] includes non-critical load,[1072] or priority and balance load, on the feeders that serve actual critical load. PREPA did not estimate the actual peak demand associated with critical load.[1073] PREPA does not consider in any comprehensive manner a system-wide resiliency approach that might target power supplies to at least some critical load directly, in the form of microgrids, single-site solar PV and battery storage, or aggregated solar PV and battery storage (VPPs) providing distributed resiliency. PREPA did not look in detail at microgrid options and VPP alternatives to gauge how they might focus directly on critical load, especially in consideration of striving for an optimal expenditure on MiniGrid resources – that is, an avoidance of some fraction of the $5.9 billion in MiniGrid transmission expenditures - other than to identify that up to 193 MW of critical load could exist, for the areas they see as potentially served by microgrids.[1074] For that identification, PREPA did not provide any "recommendation or proposal for the actual microgrid system".[1075]

724. PREPA requires local capacity provision by thermal resources within the MiniGrid regions to meet 75% of PREPA-defined critical load.[1076] PREPA does not allow for any form of local solar PV or battery energy or capacity resource to potentially meet a portion of that part of critical load when determining the overall capacity requirements

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1069 PREPA's Response to NFPs' ROI 1-1, September 11, 2019.

1070 LEOs, Direct Testimony of Mr. Sandoval, pages 10-12; NFP, Direct Testimony of Mr. Ackerman, pages 19, 22. LEOs, Final Brief, pages 37-38.

1071 Appendix 1, Exhibit 2-2.

1072 *Id.* at page 2-4.

1073 PREPA's Response to the Energy Bureau's ROI 2-9(c) provided profiles of load at substations within the MiniGrid regions, but no direct estimation of the total of actual critical load peak was presented in the Proposed IRP or responses to ROIs.

1074 Appendix 1, Exhibit 2-4, "Microgrid Deemed Critical and Priority Loads in 2019 Night Peak Case, MW". The sum of all load in the "Critical" column is 192.8 MW; the "priority" load summation is 24.1 MW, and the "balance" load is 118.6 MW.

1075 *Id.* at page 2-8.

1076 Appendix 1, page 2-5.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

for each resource development Scenario.[1077] As noted above, two intervenor witnesses directly testify[1078] that sole reliance on thermal resources to meet critical load capacity needs is not necessary, and other intervenors also note that solar PV and battery energy storage resources can be available to meet critical load needs.[1079]

725. The Energy Bureau **FINDS** that PREPA has not demonstrated that all critical load must be served solely with thermal resources. There is no evidence provided by PREPA that solar PV and batteries could not supply a substantial portion of the actual critical load that exists across Puerto Rico, or that such resources couldn't provide real, tangible contributions to the provision of a sufficient level of resiliency for PREPA customers.

726. The Energy Bureau also **FINDS** that there is no support for the stringency of PREPA's effective local capacity reserve requirement, whereby each of the eight MiniGrid regions must meet 75% of PREPA's forecast of as-defined "critical" peak load, with thermal capacity resources. The Energy Bureau **FINDS** that, as proposed, this requirement may lead to increased costs for capacity resources that are not necessarily needed for resiliency provision. When setting the proposed capacity requirement, PREPA does not allow for (i) the provision of service to critical load from solar PV or battery resources, (ii) the reduction of thermal capacity requirement through direct provision of critical load service by on-site resources or microgrid services after a storm event.; or (iii) capacity transfers between MiniGrid regions when setting this reserve requirement, even though it plans to harden connections between MiniGrid regions.[1080]

727. The Energy Bureau **FINDS** that there is no support for PREPA'S capacity planning assumption that each of the eight MiniGrids must independently maintain this level of local thermal capacity reserve with no opportunity or consideration for power transfers between MiniGrids to contribute to meeting a portion of actual critical load.

ii. Value of distributed resources to contribute to resiliency needs

728. PREPA does not comprehensively analyze the costs of any competing alternatives, supplements or complements to its MiniGrid vision,[1081] and thus provides no direct cost

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[1077] Id. at page 2-6.

[1078] NFPs, Direct Testimony of Mr. Ackerman at page 19; LEOs, Direct Testimony of Mr. Sandoval at pages 11-12, 16, and 29.

[1079] RMI, *Amicus Curiae* Brief, at pages 20-24; LEOs, Direct Testimony of Prof. Irizarry Rivera at pages 20-22, and 27-28; Sunrun, Direct Testimony of Mr. Rauscher at pages 20-22.

[1080] PREPA's MiniGrid proposal includes more than $100 million in planned transmission investment for just the "Interconnection of MiniGrids" in the first five years of deployment. Proposed IRP, Exhibits 10-7 and 10-9.

[1081] PREPA notes inclusion of the potential for microgrids to serve some load, but only provides a "high level estimation" of the generation needed and does not recommend a specific microgrid proposal PREPA includes

comparisons with alternative resilient system proposals. This is a major flaw of PREPA's proposal for MiniGrid investment. PREPA does not attempt to differentiate transmission costs across its different Scenarios, making no attempt to estimate any avoided transmission or distribution cost that may result from certain patterns of DG or VPP investment.[1082]

729. Intervenors including Sunrun, LEOs (Mr. Sandoval, Dr, Irizarry Rivera), NFPs (Mr. Ackerman, Dr. Woychik), SESA-PR (Mr. Wilson), and RMI's *Amicus Curiae* Brief presented information on alternative approaches, as described above. Some of the approaches considered by intervenors could lead to the avoidance of transmission or distribution costs,[1083] depending on how PREPA would optimize spending for MiniGrid wires investment, and thus potentially provide more cost-effective resiliency in the event of a major storm event that caused transmission lines to go out of service.

730. Sunrun, NFPs, LEOs, SESA-PR and RMI all present variations on a similar theme of provision of distributed resiliency, with a focus on renewable resources and battery systems located locally around the Commonwealth, including the use of microgrids[1084] and/or the use of VPPs,[1085] potentially of different scale including at the level of individual residential dwellings with solar and battery storage.[1086] Sun Run and SESA-PR describe DG systems that can be made available to PREPA, providing some of the required capacity resource also required to complement solar PV renewable energy.[1087]

731. Mr. Sandoval notes that the Sandia study[1088] estimated a $1.2 to $2 billion cost for a system with 159 "resilience" nodes, with a less-costly variant of $300 to $400 million providing much of the benefit. Moreover, RMI noted that 20,000 critical facilities could be made resilient with investments of 700 MW of solar PV, and 900-1,000 MWh of battery energy storage. Sunrun indicated a cost of roughly $200/MWh for battery

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a fixed amount of assumed customer distributed generation, but does not assume that it could provide any form of VPP resiliency. Appendix 1, Section 2.3.4, pages 2-8 through 2-11.

[1082] PREPA's Response to the Energy Bureau's ROI 1-56, July 11, 2019.

[1083] Sunrun, Direct Testimony of Mr. Chris Rauscher, October 23, 2019, page 6: "…the added value of T&D peak capacity and distribution level services must be taken into account as value that distributed storage can provide. This can be calculated in terms of specific avoided infrastructure costs or in relation to the marginal cost for T&D capacity on the PREPA system. Given the generalized need for T&D investment and hardening across the PREPA system, it would be appropriate to assign a value to all Virtual Power Plant resources on the distribution grid set to the marginal T&D capacity cost."

[1084] LEOs, Direct Testimony of Mr. Ronny Sandoval testimony, October 23, 2019, p. 14-16.

[1085] Sunrun, Direct Testimony of Mr. Chris Rauscher, October 23, 2019, page 4.

[1086] LEOs, Direct Testimony of Dr. Agustín Irizarry Rivera, October 23, 2019, pages 9-10.

[1087] Sunrun, Direct Testimony of Mr. Chris Rauscher, October 23, 2019, page 15; SESA-PR, Direct Testimony of Mr. Wilson, page 17.

[1088] LEOs, Direct Testimony of Mr. Ronny Sandoval, October 23, 2019, p. 15-16.

storage systems,[1089] and PREPA's own "grid defection unit" computations showed costs of roughly $200/MWh for solar PV and battery storage combined at the residential scale.[1090]

732. While the proposals and testimonies of intervening parties do not provide a comprehensive picture of an approach to resiliency that would allow for direct comparison with PREPA's proposal, they do spotlight, and rationally explain, the value of a critical set of resources that PREPA has not sufficiently analyzed as part of an approach to provide needed resiliency. Sandia's study, as noted by Mr. Sandoval, and Rocky Mountain Institute's briefing show overall costs far less than PREPA's $5.9 billion MiniGrid proposal. Sunrun's VPP cost descriptions[1091] show that incremental system resiliency could be obtained from distributed resources comprised of solar PV and battery storage systems that would be procured as part of any resource scenario, and which could help to avoid transmission system costs if those resources were procured prior to building such transmission capacity.

733. Mr. Rauscher's testimony on the capabilities and value of distributed solar PV and storage, in the form of aggregations of these resources or VPPs, is particularly useful as it characterizes the attributes and capabilities of these resources in the context of Puerto Rico's need for resiliency solutions.[1092] Dr. Bacalao has acknowledged the value of distributed solar plus storage, in the form of VPPs, as long as they are visible to PREPA and can provide the same services as utility-scale solar PV and storage provide for the system.[1093] Mr. Rauscher demonstrates the overall value of VPPs,[1094] notes that they could provide further resiliency and offset the need for some of the transmission hardening that will otherwise occur.[1095] Sunrun notes the importance of DG to comply with Act 17.[1096]

[1089] Sunrun, Direct Testimony of Mr. Chris Rauscher, October 23, 2019, page 7.

[1090] Appendix 4: Demand Side Resources, Exhibit 3-18.

[1091] Sunrun, Direct Testimony of Mr. Chris Rauscher, October 23, 2019, pages 10-12.

[1092] Sunrun, Direct Testimony of Mr. Chris Rauscher, October 23, 2019, pages 4-5.

[1093] Testimony of Dr. Bacalao, February 6, 2020, morning session, 02:26 to 03:00.

[1094] Sunrun, Direct Testimony, of Mr. Chris Rauscher, October 23, 2019, pages 3-9.

[1095] *Id.* at pages 6 and 9.

[1096] Sunrun, Final Brief, noting Act 17-2018: Section 1.6 (8) To facilitate the interconnection of distributed generation to the electric power grid through any available mechanism including, but not limited to, distributed generation, renewable energy sources, net metering, and the use of microgrids by implementing the mechanisms, strategies, and technologies available in the electric power industry for such purposes; and(9) To encourage the use of energy storage technology for consumers at all levels to facilitate and accelerate the integration of renewable energy sources and capitalize on their capacity as a distributed generation mechanism.

734. The Energy Bureau **FINDS** that intervenor testimony demonstrates the inherent value of small-scale distributed resources in the form of microgrids, single-site solar PV and battery storage, and aggregated solar PV and battery storage (or VPPs) for Puerto Rico as a critical part of an overall solution to ensure resiliency. The Energy Bureau further **ORDERS** PREPA to include the ability of small-scale distributed resources that include solar PV and battery storage serving a portion of critical load to be part of its solution for ensuring a more resilient electric power system. The Energy Bureau includes as part of its Modified Action Plan an Optimization Proceeding to determine the optimized transmission investments associated with a scaled-down, refined and more optimal approach to considering MiniGrid transmission investment. The ability for small-scale distributed resources to contribute to resiliency needs is to be assessed as part of that proceeding.

735. PREPA did not describe any differences between the extent and timing for provision of resiliency associated with its MiniGrid approach, versus a more distributed approach. While PREPA notes the early-year priority of installing the "MiniGrid backbone" system,[1097] until such systems are in place, the ability to respond to a storm event is not complete. Comparatively, PREPA did not address the extent to which a distributed resilience approach could sequentially, and potentially more quickly than its MiniGrid approach, install points of resilience throughout Puerto Rico, as PREPA proceeds with near-term procurement of solar PV and battery systems that are called for in all of its resource plan scenarios, independent of installation of MiniGrid transmission system components.

736. The Energy Bureau **DETERMINES** that rapid deployment of points of distributed resiliency, including the use of microgrid, single-site solar PV and battery resources, or aggregated VPPs must form a part of PREPA's near-term approaches to developing a more resilient grid. The Energy Bureau **ORDERS** PREPA as part of the modified Action Plan to provide analysis of the least cost options and incorporate such deployment, for the initial MiniGrid region chosen for analysis undertaken as part of the Optimization Proceeding discussed in the Modified Action Plan.

iii. Value of lost load

737. PREPA's VOLL, an assessment of the value of resiliency, demonstrates that even at relatively lower levels of the value of losing load (*i.e.*, \$2,000/MWh),[1098] the economic impact of the lost load is severe if it continues for weeks at a time.[1099] However, while PREPA's statement that a 2 to 4 week duration of outage would "…pay for the entirety

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[1097] *Id.* at Exhibit 10-7 and 10-9, "Priority 1" years 2020-2022 for transmission installations.

[1098] VOLL originally starts at a higher level, but PREPA uses a lower \$2,000/MWh value in its final analysis. Appendix 1, page 2-104.

[1099] *Id.*

of the required CapEx for the MiniGrid,"[1100] may be true, and PREPA's analysis suggests the importance of resilience to minimizing economic loss, it does not support PREPA's conclusion that its MiniGrid plus local resource design is the only, or the most cost-effective way to achieve the avoidance of economic loss after a storm. A form of distributed resilience provision could also alleviate the economic losses associated with outages, and there is no evidence in PREPA's filing indicating sufficient resilience could not be achieved less expensively than with PREPA's full-scale MiniGrid approach.

738. The Energy Bureau **FINDS** that PREPA's VOLL analysis demonstrates the importance of reducing longer-duration load loss, however, it provides no comparison of the cost-effectiveness across different approaches to reduce such lost load. The Energy Bureau, therefore, **FURTHER FINDS** that PREPA's VOLL assessment does not demonstrate that its MiniGrid approach is the only means to reduce the economic losses associated with load lost after a hurricane or severe storm and that further analysis of least cost methods is needed.

c. MiniGrid approach cost optimization

739. PREPA directly acknowledges that they did not optimize spending considerations for MiniGrid costs, stating that there is room for optimization in how the MiniGrid construct serves critical loads, as some of this load could be served independently of non-critical loads on the same feeder.[1101]

740. PREPA claims that its MiniGrid approach is "least cost",[1102] but does not provide an estimate of the costs of alternative arrangements centered on either distributed resiliency approaches alone, or a hybrid approach. A hybrid approach could strive to optimize the transmission expenditures needed, appreciating the different requirements across Puerto Rico (*e.g.*, rural vs. urban, or different geographical density of load). Hardened T&D in some areas, complemented with distributed resource investment in other areas - including use of microgrids and/or stand-alone use of solar PV and battery resources (individually, or in the aggregate as VPPs), or small thermal capacity[1103] - is one example of such an optimization. PREPA states that in some areas, "it would be impractical or excessively costly to try to maintain a reliable supply with transmission after a major event",[1104] but it does not apply that observation to its own

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[1100] *Id.*

[1101] Dr. Bacalao, Evidentiary Hearing, February 5, 2020, morning session, 00:33 to 00:38.

[1102] *See* Proposed IRP, page 1-8. "The business case for transforming the grid architecture is straightforward: is provide the least cost approach to achieve resilience again major hurricanes, meet and exceed compliance with the renewable portfolio standard, engage customers, and lower cost."

[1103] PREPA identifies microgrid zone possibilities and notes the potential use of single-MW scale thermal peaking resources. Appendix 1, *e.g.* at page 2-59.

[1104] Appendix 1, page 2-8, Section 2.3.4, "Microgrid Considerations".

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

MiniGrid system and does not test the sensitivity of overall costs to any form of hybrid approach.

741. The Energy Bureau **ACCEPTS** the MiniGrid concept as a mechanism to provide resiliency during the loss of transmission or distribution system operations due to severe weather events. Nevertheless, the Energy Bureau **DOES NOT APPROVE** the MiniGrid design/construct as proposed by PREPA due to its lack of optimization of MiniGrid transmission system expenditures and distributed resiliency approaches.

742. The Energy Bureau **REJECTS** PREPA's assertion that the overall MiniGrid construct, as proposed by PREPA, is a "least cost" approach to achieving resiliency against major hurricanes. PREPA has not shown how its MiniGrid construct may be a less expensive approach than reasonable alternative approaches that include localized, distributed solutions along with an optimized level of MiniGrid-like T&D system expenditures. PREPA did not provide an analysis of alternative resiliency options to support its assertion that its approach is the least cost. Given the lack of analysis of reasonable alternatives and of cost optimization of the MiniGrid construct, the Energy Bureau **FINDS** that PREPA has not supported, and as such, has not demonstrated, its assertion that the overall MiniGrid construct is a "least cost" approach to achieving resiliency against weather events.

d. Transmission and distribution

743. PREPA's T&D plans include extensive hardening of existing facilities, and planned investment in new hardened facilities (for MiniGrid transmission, and distribution) primarily through the undergrounding of lines and investment in GIS substation equipment for protection from outages under extreme weather conditions. For existing infrastructure, the planned investment will bring the equipment up to standards, and for new installations the investment can serve to improve resiliency, interconnect resources, and improve the overall efficiency of electricity delivery.

744. PREPA does not distinguish between T&D investment requirements across different resource plans. PREPA did not consider how a resource plan or implementation strategy might affect the overall costs of T&D investments. Notwithstanding the foregoing, PREPA does acknowledge that optimizing transmission spending still needs to occur, thus it seems to be aware that different resource deployment approaches could lead to different investments in transmission, and distribution. Lack of a better analysis of the way in which resource plans could affect requirements for T&D spending is a major flaw in the Proposed IRP. Therefore, the Energy Bureau's findings and Modified Action Plan direct PREPA to i) improve this analytical aspect in the next IRP cycle, and ii) further examine these issues in a new proceeding following issuance of this Resolution and Order, as will be described in Part IV of this Final Resolution and Order.

i. Existing transmission system

745. PREPA's plan to harden its infrastructure, and bring existing transmission system assets up to new Codes and new Standards is not only reasonable as part of resource planning, it is required by the new energy public policy[1105] and by FEMA.[1106] PREPA's centralized power supply will continue to be required to provide reliable service, and thus the existing 230 kV, 115 kV and 38 kV systems need to be fully and properly maintained to be available for operation after storm events. Even with the accelerated procurement of distributed supplies across Puerto Rico, conventional generation in the south, west and in the north – as well as any new utility-scale solar PV and battery installations - will need to be supported with a fully functioning, standardized reliable transmission system. The transmission system must be reliably available to transfer energy over the next decade and beyond.

746. The Energy Bureau recognizes the need for these upgrades. The Energy Bureau thus **ACCEPTS** PREPA's plans to spend up to $2 billion[1107] for transmission hardening of existing elements and aging infrastructure. Nevertheless, this acceptance **SHALL NOT** be construed as an approval of the specific expenditures listed[1108] in the Proposed IRP. The Energy Bureau **ORDERS** PREPA to timely seek the Energy Bureau's approval for the specific expenditures prior to making any investments. As part of the Energy Bureau's Modified Action Plan, further identifying, prioritizing, and sequencing the planned investments[1109] will be addressed in compliance actions that will include, in part, consideration of some investment in MiniGrid-related transmission infrastructure, as discussed below.

ii. MiniGrid transmission

747. PREPA's plans to invest in additional transmission system infrastructure, up to $5.9 billion, as part of its MiniGrid approach are not supported by PREPA's analyses. PREPA did not conduct any comparative cost analyses to assess the extent to which distributed resilience solutions in some regions (*e.g.*, in the form of microgrids and single-site energy and capacity provision approaches at identified and selected locations, or the use of VPPs in a more aggregate manner) could complement the MiniGrid approach in other regions.

[1105] *See* Act 17, § 1.15 (a) through (g).

[1106] Appendix 1, page 2-103.

[1107] *Id.* at Exhibit 10-11; Appendix 1, Exhibits 2-97 and 2-98.

[1108] Confidential Attachment to PREPA's response to Energy Bureau ROI 1-6 a), August 2, 2019.

[1109] The Energy Bureau anticipates that the starting point for this exercise will be PREPA's list of "Planned Transmission Projects on Existing Infrastructure" as provided in Confidential PREPA ROI_1_6 Attachment 1 to the PREPA's response to the Energy Bureau's Requirement of Information, 1-6(a).

748. However, some aspects of PREPA's planned hardening of existing infrastructure related to the MiniGrid approach,[1110] potentially some new MiniGrid transmission investments, or the combination of investment in existing and new infrastructure for specific regions could be supported under an approach that includes both distributed resilience via small-scale energy and capacity resources and optimized MiniGrid-like transmission investment. In particular, as part of a modified Action Plan the Energy Bureau will structure a separate exploration of specific MiniGrid transmission investment options for one of the denser load areas in Puerto Rico, for example the San Juan – Bayamón region, or the interconnection of this MiniGrid area to an adjacent MiniGrid region.

749. The Energy Bureau's Modified Action Plan describes the planned compliance path for PREPA to seek the "optimization" that PREPA acknowledged was lacking in its analysis,[1111] and to consider some MiniGrid-like transmission investment in, initially, one region or across two adjacent regions, if they prove to be cost-effective and provide the resiliency required by public policy.

750. Simultaneously, compliance with the Modified Action Plan will include provision of distributed resiliency approaches in other regions through PREPA procurement opportunities, and/or coordination with prosumers for solar PV and battery storage combinations, and potentially other capacity sources such as small thermal units, in different forms, including microgrid solutions, aggregations of resources (such as VPPs) and single-site locations utilizing DG and battery storage as necessary.

751. Ensuring that the transmission system can support the injection of new solar PV and battery supply from utility scale resources is also required under Regulation 9021.[1112] PREPA's conclusions in Appendix 1 indicate that at this time, the transmission system can generally support installation of new battery and solar PV resources.[1113] Location-specific analyses, controls for new battery installations, and the presence of improved voltage response capabilities with synchronous condensing from converted steam plants will all be required.

752. The Energy Bureau **FINDS** that PREPA did not properly consider an optimized transmission plan and **ORDERS** that the Modified Action Plan include the development of a resource plan or implementation strategy to optimize transmission spending. The Energy Bureau **ORDERS** PREPA to improve this aspect of its planning in the next IRP.

[1110] PREPA identifies a total of $835 million (out of a total MiniGrid transmission investment of $5.9 billion) in "existing infrastructure hardening for reliability" and "aging infrastructure replacement" as part of its MiniGrid transmission investments. *Id.* Exhibits 10-7 and 10-9.

[1111] Dr. Bacalao, Evidentiary Hearing, February 5, 2020, morning session, 00:33 to 00:38. PREPA response to Energy Bureau ROI-1-3 f), August 2, 2020.

[1112] *See* §. 2.03 (J)(1)(a)(ii).

[1113] Appendix 1, pages 3-15 and 4-59.

753. The Energy Bureau's Modified Action Plan sets out a path to consider the extent to which "optimized" MiniGrid transmission system expenditures should be made. As part of this process, any overlap between transmission investments required for existing infrastructure hardening and those that may be required to effect optimized MiniGrid investments will be considered.

iii. Distribution system

754. PREPA's plans for investment in its distribution system include specific estimates for costs - $911 million in total - to harden feeders and substations for resiliency, allowing for more reliable delivery after storms.[1114] PREPA does not provide specific cost information for incremental costs associated with upgrades or controls required to address increasing penetration of DG.[1115] PREPA stated that 45 feeders[1116] potentially could have technical issues with DG interconnection, but did not provide estimated costs per feeder; nor did PREPA directly indicate the extent to which resiliency investments would cover some portion of costs that might be needed for specific DG incorporated on feeders going forward.

755. PREPA's planned expenditures to improve resiliency across the distribution system primarily by undergrounding feeder mainlines and hardening substations are reasonable, as long as PREPA directly and consistently incorporates the need to allow feeders to host DG. PREPA notes that "the priority order and actual investments may be modified considerably"[1117] when describing the detailed substation locations for hardening. The Energy Bureau notes that, as PREPA continues the process of identifying and prioritizing these types of distribution investments, not only should the topology and operational limitations[1118] be considered, but all other ongoing distribution system analysis must be incorporated into the decisions for substation and feeder investments.

756. PREPA must further ensure that the improvements required for resiliency align with and reflect a prioritization for the type of investment that supports increasing the ability for DG to be connected to the distribution system. As PREPA considers the

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[1114] *Id.* at Exhibit 10-19.

[1115] *Id.* "… Siemens conducted a high level estimation … the distribution analysis above can only be used for screening purposes and it is not a substitute for the necessary detailed system studies that must consider the feeder topology, assets in service, and location of the load the PV systems. This future detailed analysis, which is beyond the scope of this evaluation, must include and evaluation of the expected performance of equipment, refinement of the definition of the necessary improvements, capital expenditures, and timing to implement the projects".

[1116] *Id.* at Exhibit 10-18.

[1117] *Id.* at page 5-4.

[1118] *Id.*

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

voltage consolidation it discusses in the Proposed IRP, it should ensure that all voltage upgrades and voltage control additions to the distribution system explicitly focus on maximizing the ability of the system to support more DG. As PREPA considers distribution resiliency investments, it must conduct and report upon the specific analyses required – those that were described as "beyond the scope of this [IRP] evaluation"[1119] – to further progress towards allowing all of its system to incorporate DG.

757. The Energy Bureau in its modified Action Plan will require compliance reporting that mandates PREPA complete its Integrated Distribution System Planning and solar PV, battery storage, and other DG hosting capacity analyses across its distribution system.

758. The Energy Bureau **CONDITIONALLY ACCEPTS** PREPA's plans for $911 million in distribution system investments for resiliency and support for DG. The Energy Bureau **ORDERS** PREPA to coordinate all distribution system spending with its ongoing efforts in integrated distribution system planning and maximizing the ability of the distribution grid to integrate DG, especially solar PV and batteries required throughout Puerto Rico as part of the modified Preferred Resource Plan, set out in the Modified Action Plan. However, until an Integrated Distribution System Plan is developed by PREPA and approved by the Energy Bureau, PREPA shall proceed on a parallel path of maximizing the ability of the distribution grid to incorporate all forms of DG. The Energy Bureau **ORDERS** PREPA to ensure that all voltage upgrades and voltage control additions to the distribution system explicitly focus on maximizing the ability of the system to support more DG.

759. The distribution system will need to be hardened to withstand the effects of weather events under various forms of resiliency provision. The Energy Bureau **DIRECTS** PREPA to specifically consider how distribution system investments for resiliency may be modified to reflect an optimized approach to MiniGrid transmission investment. To that effect, the Energy Bureau **ORDERS** PREPA to directly consider distribution system planning impacts in the Optimization Proceeding, discussed in the Modified Action Plan.

IV. ACTION PLAN

760. Regulation 9021[1120] describes the purpose of the Action Plan as specifying the implementation actions required of PREPA during the first five years of the planning period, as set out in the Preferred Resource Plan. Regulation 9021 also describes Action

[1119] *Id.* at page 10-19.

[1120] *See* Regulation 9021, § 2.03 (K)(1) and (2).

Plan Documentation and Development elements, including the need to document expected procurement processes for supply- and demand-side resources, and to develop the Action Plan based on a Preferred Resource Plan that uses the lowest-cost net present value of revenue requirements as its primary criterion.

761. In this Part of the Energy Bureau's Final Resolution and Order, after summarizing PREPA's Action Plan elements from the Proposed IRP and describing intervenor submissions, the Energy Bureau sets out its reasoning and findings, and **ORDERS** a Modified Action Plan for PREPA's implementation in accordance with the Orders and Directives set forth below in this Part IV of the Energy Bureau's Final Resolution and Order.

A. PREPA Filing

762. PREPA's proposed Action Plan is contained in Part 10 of the Proposed IRP, and is also detailed in its Introduction and Summary of Conclusions, in Part 1 of the Proposed IRP.[1121] PREPA's proposed Action Plan elements are categorized in three groups: supply resources ("Greening the Supply"); transmission investments ("Creating a Resilient Grid"); and distribution system, DG, EE, and DR ("Engaging the Customer").[1122] These elements are summarized in the subsections below, although we have moved our discussion of distribution system investments to the same subsection as transmission.

763. In the introduction of the Action Plan, and applying to all of the intended actions, PREPA states its intention to solicit bids from vendors to design, build, and finance (as well as operate and maintain where relevant) the identified projects, and then sell the power or use of the project to PREPA.[1123] In this way, the capital expenditures would be financed and incurred by vendors, and PREPA would make payments through its operating, rather than capital budget.

764. At the Evidentiary Hearing, Dr. Bacalao testified regarding the elements of the Action Plan that are "no regrets" and "least regrets."[1124] He identified as "no regrets" actions the deployment of renewables and storage; integration of DG; maximizing EE; and the hardening of T&D at MiniGrid level. He identified as "least regrets" actions conducting planning and engineering studies for baseload, fast responding generation[1125] in the

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[1121] *See* Proposed IRP, pages 1-5 to 1-12, and pages 10-1 to 10-22.

[1122] *Id.* at page 10-1.

[1123] *Id.* at p. 10-1.

[1124] Evidentiary Hearing, February 7, 2020, morning session, 01:32:00 to 01:34:00.

[1125] Dr. Bacalao defined "baseload, fast responding" generation as generation with a low heat rate that can be run cost-effectively at capacity factors above 70%, that can be cycled daily (or faster), and can respond very fast (that is, fast ramping). *Id.* at 01:34:20 to 01:35:05.

North (specifically at Palo Seco) and then in Yabucoa and Mayagüez. Mr. Paredes of PREPA testified that PREPA shares these views.[1126]

1. Supply Resources

a. Existing thermal resources

765. The Proposed IRP's Action Plan takes as a fixed decision the conversion of San Juan 5&6 combined cycle units to natural gas.[1127] This conversion was structured as a capacity payment, so it does not require capital expenditures from PREPA.[1128]

766. At the time of filing the Proposed IRP, PREPA had not yet reached an agreement with EcoEléctrica regarding a new contract for service from that facility. The Proposed Action Plan includes renegotiating that contract.[1129] In the intervening time, PREPA and EcoEléctrica reached an agreement, and the Energy Bureau approved that agreement after making the corresponding analysis[1130] of the proposed contract terms in the context of the IRP.[1131]

767. Operation of PREPA's electrical system with high penetrations of inverter-based solar and battery systems would be aided by the addition of synchronous condensers, which can increase the short-circuit level and improve voltage stability. As PREPA's older steam units retire, the Proposed Action Plan states that PREPA will investigate converting some or all of them into synchronous condensers.[1132] Potential units include San Juan 7, 8, 9, and 10, Aguirre 1 and 2, and Palo Seco 3 and 4.[1133] The Proposed Action Plan states that the selection of specific units and the schedule for their conversion would require further study.[1134] PREPA estimates a cost of approximately $9 million to convert each unit.[1135]

[1126] *Id*. at 01:34:00.

[1127] *See* Proposed IRP, page 10-3.

[1128] *Id.* at page 10-3 – 10-4.

[1129] *Id.* at page 10-4.

[1130] Energy Bureau's ROI 10, December 13, 2019; PREPA's Response to Energy Bureau's ROI 10, January 22, 2020.

[1131] Resolution and Order, In Re: Request for Approval of Amended and Restated Power Purchase and Operating Agreement with EcoEléctrica and Natural Gas Sale and Purchase Agreement with Naturgy, Case No. NEPR-AP-2019-0001, March 11, 2020.

[1132] *See* Proposed IRP, page 10-4.

[1133] *Id*.

[1134] *Id*.

[1135] *Id*.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

768. The Proposed IRP analysis and Action Plan assume that San Juan 9 and 10 are out of service and set to be retired or for limited use only.[1136] The Action Plan identifies other units that are set to retire during its five-year period, contingent on reductions in load, maintaining reliability, and the commissioning of new generation resources.[1137] The potential retirements include all of the Frame 5 peakers, Aguirre steam 1 and 2, Costa Sur 5 and 6, and San Juan 7 and 8.[1138]

b. New renewable resources and storage

769. The Proposed IRP Action Plan states that PREPA plans to install and interconnect 1,800 MW of solar PV during the first five years of the plan: 300 MW in 2020, 480 MW in 2021, 600 MW in 2022, and 420 MW in 2023.[1139] It also states a plan to install 920 MW of BESS: 40 MW in 2019, 200 MW in 2020, 480 MW in 2021, and 80 MW in 2022.[1140] These BESS systems would be composed of 240 MW of 2-hour BESS, 640 MW of 4-hour BESS, and 40 MW of 6-hour BESS.[1141]

770. PREPA expects to run procurement processes in blocks of approximately 250 MW of solar PV, with associated battery storage.[1142] PREPA plans to consider soliciting standalone solar PV, combined solar PV and BESS, and standalone BESS.[1143] PREPA identifies that the pace of acquisition and interconnection is limited by PREPA's internal capabilities for procurement and approval, but also states that the concessionaire or additional PREPA resources may allow these capabilities to be expanded.[1144] During the Evidentiary Hearing, Mr. Paredes testified that PREPA's interconnection process is limited by internal capacity to conduct interconnection studies, and that external engineering assistance could increase this capacity.[1145] In the Proposed Action Plan, PREPA also states that achieving the timelines envisioned in the

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1136 *See* Proposed IRP, page 10-4.

1137 *Id.* at page 10-5.

1138 *Id.*

1139 *See* Proposed IRP, Exhibit 10-1, page 10-2.

1140 *Id.* at Exhibit 10-2, page 10-3.

1141 PREPA Workpaper, "ESM_Metrics_Bass_SII.xlsx". The Proposed Action Plan contains a different allocation between durations, which does not sum to 920 MW.

1142 *See* Proposed IRP, page 10-2.

1143 *Id.* at pages 10-2 to 10-3.

1144 *Id.* at page 10-2.

1145 Evidentiary Hearing, February 6, 2020, morning session, 3:11:30 to 3:12:30.

plan would require expedited permitting and financial backing for PPOAs with these facilities.[1146]

771. PREPA's first two supply resource actions from the IRP include development of solar PV and battery energy storage resources.[1147] PREPA states that "up to 1800 MW" of solar PV, and 920 MW of battery energy storage is to be installed in the first five years of the ESM plan.[1148] PREPA states that Requests for Proposals (RFP) will be issued for solar PV blocks sized at approximately 250 MW, and for battery energy storage capacity blocks sized at approximately 150-200 MW.[1149] In response to the Energy Bureau's ROI-9,[1150] PREPA updates its Proposed Action Plan to recognize that if load is higher, as is seen under the No EE and Low EE Scenarios tested in the modeling in response to ROI-9-1, then the amount of solar PV and battery energy storage needed would be higher. PREPA states that "the action plan in this respect can be summarized in install [sic] the maximum amounts of PV in the first five years of the plan with a target of 2,760 MW at or before 2024".[1151] PREPA notes this level would be installed for either No EE or Low EE Scenarios. PREPA notes that cumulative installations of battery energy storage systems would reach 1,440 MW by 2024 under either the No EE or Low EE Scenarios, an increase above the 920 MW seen in the original ESM Plan.

c. New thermal resources

772. The Proposed Action Plan calls for a new 302 MW CCGT at Palo Seco, to be online by January 2025.[1152] PREPA states that in order to be online at that date, work on the project would need to begin immediately.[1153] The Proposed Action Plan also calls for a new LNG terminal at San Juan to supply natural gas to both San Juan and Palo Seco gas plants by 2025.[1154] Any delays would require that ship-based LNG be used for both sets

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[1146] *See* Proposed IRP, page 10-3.

[1147] *Id*. pages 10-2 and 10-3.

[1148] *Id*.

[1149] *Id*.

[1150] Energy Bureau ROI 9, October 29, 2019. PREPA's response to this ROI on December 6, 2019 including modeling results for the ESM, S3S2, S4S2, S5S1 and S1S2 Scenarios, for both Low EE and No EE load levels, which represented lower levels of Energy Efficiency and thus higher load.

[1151] *Id.* at page 15.

[1152] *Id*. at page 10-5.

[1153] *Id*.

[1154] *Id*. at page 10-6.

of plants.[1155] Operation of a gas plant at Palo Seco also requires construction of a gas pipeline between the San Juan and Palo Seco sites.[1156]

773. The Proposed Action Plan discusses the option to develop a new 302 MW combined cycle plant at Costa Sur in the event that negotiations for a new contract with EcoEléctrica were to fail to reach a satisfactory agreement.[1157] This item is moot due to the EcoEléctrica Agreement and Energy Bureau approval of such agreement.

774. The Proposed Action Plan calls for installation of 18 gas turbine peaking units of 23 MW each, at five locations (2 at Jobos, 4 at Mayagüez North, 5 at Carolina (Daguao), 5 at Caguas (Yabucoa) and 2 at (Cayey).[1158] These units would generally replace the existing Frame 5 units and be capable of burning containerized natural gas as well as diesel fuel.[1159] The Proposed Action Plan states that these units should be placed in service as soon as practical.[1160]

775. The Proposed Action Plan presents two additional sets of thermal resources as hedges against uncertainties: a 302 MW CCGT and ship-based LNG facility at Yabucoa, and at Mayagüez a ship-based LNG facility with gas conversion of existing peakers and construction of a new 302 MW CCGT.[1161] PREPA states that the Proposed Action Plan contains only preliminary permitting and engineering for these projects, and that the need for them would be re-evaluated prior to making any large commitments for equipment purchase or construction.[1162]

2. Transmission and Distribution

776. PREPA's Proposed Action Plan recommends three foundational elements for the T&D system: 1) creation of a resilient transmission grid, which is focused on supporting "MiniGrid" and microgrid operations; 2) transmission reliability investments, which are required to bring the transmission system up to current or new standards and to reconstruct aging infrastructure; and 3) distribution system investment for resiliency of supply to customers consistent with the MiniGrid construct, and in support of

[1155] *Id.*

[1156] *Id.*

[1157] *See* Proposed IRP, page 10-5.

[1158] *See* Proposed IRP, page 10-6.

[1159] *Id.*

[1160] *Id.*

[1161] *See* Proposed IRP, page 10-7.

[1162] *Id.*

distributed resource integration, in particular to support rooftop solar PV installations.[1163]

a. Transmission

777. PREPA's transmission system investments are planned for installation across five priority time periods, in five blocks of three, two and one-year timeframes (2020-2022, 2023-2024, 2025-2026, 2027, and 2028).1164 Priority 1 and Priority 2 projects fall within the five-year timeline of the Proposed Action Plan. The investments would consist of both 115 kV and 38 kV equipment components including line hardening and reconstruction, new overhead and underground lines, switchyard hardening and reconstruction, and new substation and switchyard construction.[1165] Most of the substation-related expenditures are linked to converting substations to gas-insulated switchgear.[1166] The investments are categorized into six "Technical Justification" areas: MiniGrid Main Backbone, Interconnection of Critical Loads, MiniGrid Backbone Extensions to Create High Reliability/Resiliency Zones, Interconnection of MiniGrids, Existing Infrastructure Hardening for Reliability, and Aging Infrastructure Replacement. Of these six areas, the first four are exclusively related to the MiniGrid resilience investment proposal, and the last two (related to hardening for reliability and aging infrastructure) are split between investments in support of MiniGrids and reliability investments required to meet the standards on the transmission system.

778. Within the transmission investments in the Action Plan, most of the expenditure is identified for Priority 1 and Priority 2 actions in support of the MiniGrid proposal. The largest components are 115 kV investments in "MiniGrid Main Backbone" (including substations and undergrounding lines) and 38 kV investments in "Interconnection of Critical Loads." Together, these two components have a projected capital cost of \$3.9 billion within the Action Plan period (\$3.3 billion of which falls within Priority 1).[1167] Total projected MiniGrid-related transmission expenditures in the five-year period are \$4.8 billion.[1168]

779. Action Plan transmission reliability investments unrelated to MiniGrids are not front-loaded and total about \$200 million per year.[1169]

[1163] *See* Proposed IRP, pages 10-1, 10-10, and 10-17.

[1164] *Id.* at Exhibit 10-7, page 10-11 and Exhibit 10-9, page 10-13.

[1165] *Id.* at page 10-10.

[1166] *Id.*

[1167] *Id.* at Exhibit 10-7, page 10-11 and Exhibit 10-9, page 10-13.

[1168] *Id.*

[1169] *Id.* at Exhibit 10-11, page 10-14.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

b. Distribution

780. The Proposed Action Plan identifies three main classes of distribution system investments, which support two objectives. The two objectives are to increase resiliency of supply consistent with the MiniGrid proposal and to support the integration of distributed resources, in particular rooftop solar PV.[1170] The classes of investments are 1) upgrades to substations, in particular the use of gas-insulated switchgear, but also including upgrades from 4.16 kV to 13.2 kV;[1171] 2) moving feeders that serve critical loads from overhead to underground;[1172] and 3) upgrading a set of 4.16 kV feeders to 13.2 kV to increase the ability to integrate distributed PV.[1173] In general, the substation upgrades and undergrounding support the resilience objective and the feeder voltage upgrades support PV integration.

781. The proposed capital investment in distribution infrastructure in the Action Plan period totals $716 million, of which $582 million relates to feeders and the remainder to gas-insulated substations. The Action Plan does not separate the feeder investment costs between undergrounding and voltage upgrades.

3. Demand-Side Resources

a. Energy efficiency

782. The Proposed Action Plan states an objective of achieving 2% per year in energy savings, and the potential to reduce annual energy demand by 600 GWh by 2025.1174 It does not identify specific actions or timelines to achieve these goals.

b. Demand response

783. The Proposed Action Plan calls for the creation of DR programs, with the goal of over 60 MW of demand flexibility by 2025.[1175] It does not identify specific actions or timelines for the creation of the programs.

[1170] *Id.* at page 10-17.

[1171] *Id.* at page 10-17.

[1172] *Id.* at pages 10-17 to 10-18.

[1173] *Id.* at pages 10-18 to 10-20.

[1174] *Id.* at page 10-22.

[1175] *Id.*

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

c. Distributed generation and virtual power plants

784. The Proposed Action Plan does not explicitly address DG or VPPs, beyond the distribution system investments necessary to support DG that are discussed in the distribution Part (above).

B. Intervenors

1. AES Puerto Rico

785. In his Direct Testimony, Ronald Moe testifies regarding several concerns he has regarding the Proposed Action Plan, or with the implications for the Proposed Action Plan. First, he testifies that he considers it to be unlikely that PREPA and Puerto Rico will be able to attract billions of dollars in capital investment within the next few years to develop the new resources in the Proposed Action Plan.[1176] He states that in the face of this uncertainty, PREPA should have presented an "explicit optimized backup plan (i.e., a 'Plan B')."[1177] On a related matter, Mr. Moe testifies that the actual costs of new development could be substantially different from the assumed costs, due to higher costs of capital reflecting the risk of PREPA as a counterparty. He suggests that the project cost of capital be treated as an assumption, and "remain an assumption at least until one or more PPOAs have been executed."[1178]

786. Mr. Moe also expresses concern regarding the MiniGrid analysis and associated Action Plan elements. In particular, he states that the Energy Bureau should not assess new concepts such as MiniGrid outside the context of the Proposed IRP, and that the assessment of resiliency and MiniGrids that PREPA presented in this proceeding was not adequate to support incorporation into the Proposed IRP.[1179] Mr. Moe points out that the approximately 400 MW of small GTs associated with the MiniGrid proposal are taken as fixed decisions in the modeling, and thus may be making uneconomic other, more efficient generation alternatives.[1180]

787. In its final brief, AES-PR encourages the Energy Bureau to move forward with "no regrets" actions such as EE and solar energy. AES-PR further urges the Energy Bureau to require further optimization of the MiniGrid approach and of natural gas-fired options prior to approving any of these investments.[1181]

[1176] AES-PR, Prefiled Testimony of Mr. Moe, October 23, 2019, page 3.

[1177] *Id.* at page 24.

[1178] *Id.* at page 19.

[1179] *Id.* at page 21.

[1180] *Id.* at page 20.

[1181] AES-PR, Final Brief, March 6, 2020, page 1.

788. AES-PR urges the Energy Bureau to approve an Action Plan that retains the AES coal plant through 2027 because it provides the lowest-cost electric energy available in Puerto Rico, and PREPA's modeling of early-retirement scenarios shows that such retirement would raise costs for ratepayers.[1182] AES-PR further requests that the Energy Bureau order PREPA to conduct additional analyses of the conversion of the plant to natural gas.[1183]

2. Arctas

789. In its Final Brief, Arctas addresses two subjects relevant to the Action Plan: equipment types for any potential peaker procurement and the importance of a level playing field for procurement for any Palo Seco capacity addition.[1184] Regarding peakers, Arctas urges the Energy Bureau to ensure that offers from different equipment types, including both GTs and RICE units, are encouraged, and that mobile units are not required.[1185] Arctas argues that proponents should also be free to propose the use of various fuels.[1186] Regarding potential new generation at Palo Seco, Arctas urges the Energy Bureau to ensure that Puerto Rico government assets or resources are available on an equivalent basis to any qualified bidder.[1187] These assets could include land for LNG facilities and access to PREPA berths and docks. Arctas also recommends that such a future process should not advantage an LNG terminal owner such as New Fortress Energy.[1188]

790. In its Reply Brief, Arctas provides additional recommendations regarding procurement processes and Energy Bureau approval in the Proposed IRP, particularly regarding natural gas generation or LNG facilities. Arctas states that "the Energy Bureau should timely exercise its power to ensure a competitive public procurement process which fully complies with all applicable laws and regulations related to the procurement processes."[1189] Arctas discusses the difference between procurement processes through the P3 Authority and procurement under Joint Regulation 8815, approved by the Energy Bureau on September 1, 2016. As described by Arctas, under the P3 process, projects do not come before the Energy Bureau until the final step of approval, when the Energy Bureau decides whether to issue and Energy Compliance Certificate under

[1182] *Id.* at page 9-12.

[1183] *Id.* at pages 12-13 and 15-17.

[1184] Arctas, Final Substantive and Legal Brief, March 6, 202, pages 33-39.

[1185] *Id*. at pages 33-34.

[1186] *Id*. at page 34.

[1187] *Id*. at pages 35-38.

[1188] *Id*. at pages 38-39.

[1189] Arctas, Reply to Legal Briefs, April 20, 2020, page 1.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Act 120.[1190] In contrast, Arctas describes that under Joint Regulation 8815, the Energy Bureau has the opportunity to approve the decision to issue an RFP, approve the RFP itself, and then rule on the contract itself.[1191]

791. Arctas argues that the Joint Regulation 8815 process provides greater certainty for project proponents that the eventual contract will be approved by the Energy Bureau than does the P3 process.[1192] Arctas suggest that, if PREPA is to use the P3 process, the Energy Bureau should provide specific guidance in the approved Action Plan regarding procurement processes, access to or use of PREPA or governmental entity assets, and acceptable contract terms.[1193]

792. Arctas further states that if the Energy Bureau were to approve specific budgets for PREPA's development of new generation resources, it would provide a clear signal to potential bidders that PREPA and the Energy Bureau are committed to such projects.[1194] Arctas argues that such a clear signal would enhance interest in the projects and lead to a more competitive process.[1195]

3. Environmental Defense Fund

793. In her Direct Testimony, Dr. Elizabeth Stanton expresses concern that the Proposed Action Plan does not contain sufficient new renewable generating resources to comply with the RPS unless energy demand falls as projected due to EE.[1196] She states that "(f)ailing to build out renewables in the near-term will negatively impact Puerto Rico's ability to meet the renewable energy targets contained in Act 17."[1197]

794. In its Final Brief, EDF argues that, in the face of substantial uncertainty, the Energy Bureau should develop a "no regrets" approach that produces outcomes that are "clearly needed, while avoiding any long-term commitments that could lead to high costs and stranded assets."[1198] EDF states that an Action Plan based on large additions of renewable and no new combined cycle or peaking plants "would be consistent with a 'no regrets' approach and a least cost approach."[1199] In particular, EDF recommends

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[1190] *Id*. at pages 3-4.

[1191] *Id*. at page 4.

[1192] *Id*. at pages 4-5.

[1193] *Id*. at pages 5-6.

[1194] *Id*. at pages 6-7.

[1195] *Id*. at page 7.

[1196] EDF, Prefiled Testimony of Dr. Elizabeth Stanton, October 23, 2019, page 16.

[1197] *Id*. at page 19.

[1198] EDF, Final Brief, March 6, 2020, page 39.

[1199] *Id.* at page 40.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

that the Energy Bureau approve a modified IRP based on the S3S2S8B scenario.[1200] EDF further details specific recommended actions:

- Build or contract for 3,900 MW of renewables and 1,640 MW of battery storage (through a technology agnostic/an all-resource RFP);[1201]
- Not limit capacity expansion of renewables and storage;[1202]
- Retire all steam units by 2025, except for EcoEléctrica;[1203]
- Not build, or perform any site planning and engineering, for any new gas plants during the five-year Action Plan period;[1204]
- Use tariffs or RFPs to acquire 700 MW of DG by 2025;[1205]
- Issue a technology-neutral RFP (open to supply-or demand-side solutions) for grid services such as peak capacity to meet summer peaks in the aftermath of the damages to Costa Sur;[1206]
- Develop EE and DR programs with long-term present value of budgets of $300 million or more;[1207]
- Engage customers and customer-sited assets through such approaches as VPPs;[1208]
- Conditionally approve one MiniGrid to determine if the MiniGrid concept is capable of functioning as planned, and including load management, careful vetting of generation options, and a design to deliver knowledge and experience relevant to advancing a decentralized renewable energy future;[1209]
- Re-evaluate the need to meet critical loads only with thermal resources;[1210]

[1200] *Id.* at page 42.

[1201] *Id*. at page 43.

[1202] *Id*. at page 44.

[1203] *Id*.

[1204] *Id*.

[1205] *Id.* at pages 44-45.

[1206] *Id*. at pages 45-46.

[1207] *Id*. at pages 46-47.

[1208] *Id*. at pages 48-50.

[1209] *Id.* at pages 50-51.

[1210] *Id.* at pages 52.

- Study on- and off-shore wind and hydroelectric resources prior to the next IRP;[1211]
- Conduct further optimization regarding the optimal renewable resource mix;[1212] and
- Require the next IRP to be conducted in two years, rather than three.[1213]

795. EDF further provides recommendation for the process to be used in future IRPs, including the selection of the consultant, stakeholder participation, use of RFP results for modeling, and pre-approval for the modeling tool, inputs, and assumptions.[1214] EDF further recommends that future IRP processes should use advanced grid planning methods, linked to distribution planning, and include detailed risk assessments.[1215]

796. In its Reply Brief, EDF responds to the ICPO's recommendation of an Action Plan based on S4S2S9 and reiterates its support for a modified version of S3S2S8 (without any new gas plants), on the grounds that EDF's preferred resource plan is more consistent with Act 17.[1216] EDF further disagrees with ICPO's suggestion to approve a new CCGT at Costa Sur.[1217] EDF further reiterates its argument for approving only one MiniGrid and deploying this first-of-its-kind approach gradually, in contrast to ICPO's recommendation of the full MiniGrid approach contained within S4S2S9.[1218]

4. Empire Gas

797. In his Direct Testimony, Mr. Ramón González Simounet states that LPG is a more appropriate fuel for use in peaking units[1219] because of Puerto Rico's limited natural gas infrastructure,[1220] the relatively advanced state of LPG infrastructure and markets on the Island (relative to natural gas),[1221] and the logistical challenges of delivering liquified natural gas to locations around the Island by truck.[1222] Mr. González Simounet further recommends that the LNG infrastructure proposed in the Action Plan instead

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[1211] *Id.* at page 52.

[1212] *Id.* at pages 52-53.

[1213] *Id.* at page 53.

[1214] *Id.* at pages 54-58.

[1215] *Id.* at pages 58-61.

[1216] EDF, Reply Brief, April 20, 2020, page 21.

[1217] *Id.* at pages 23-24.

[1218] *Id.* at pages 22-23.

[1219] Testimony of Mr. Ramón González Simounet, October 15, 2019, pages 38-39.

[1220] *Id*. at pages 27-28.

[1221] *Id*. at pages 26-27.

[1222] *Id*. at pages 29-30.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

be developed to import LPG and that the Mayagüez aeroderivative GTs be converted to LPG, rather than natural gas.[1223] In the near term, he further testifies that PREPA should consider converting facilities that currently burn diesel or oil to propane.[1224]

798. Empire Gas's Final Brief reiterates the recommendations in Mr. González Simounet's testimony regarding the use of LPG for peaking units, the development of LPG rather than LNG import facilities, the conversion of the Mayagüez turbines to LPG, and the conversion of existing major plants to LPG.[1225]

5. Independent Consumer Protection Office

799. In his Direct Testimony, Mr. Gerardo Cosme Núñez testifies that PREPA's proposed Action Plan in not flexible enough to address uncertainties in the load forecast and the cost or pace of deployment of renewable resources and energy storage.[1226] He further testifies that the concerns could be addressed by requiring further process and analysis prior to approving construction of any fossil-fuel generation, delivery, or storage facilities.[1227]

800. In its final brief, ICPO supports the implementation of the S4S2S9 scenario (S4S2 with the retention of EcoEléctrica).[1228] ICPO opposes the development or pre-development of fossil fuel plants at Yabucoa or Mayagüez, due to the risk that these development costs may be stranded if solar and storage development can proceed at the projected pace.[1229] ICPO favors continued use of the Costa Sur site for natural gas generation, over development of a new combined cycle plant at Palo Seco and the associated fueling infrastructure.[1230] ICPO also favors distributed renewable development in order to mitigate development risk for large renewable projects.[1231] ICPO urges the Energy Bureau to modify the Action Plan further to establish an aggressive plan for the repair and proper maintenance of the existing generation fleet, in order to utilize and maintain in service the most cost-effective units.[1232] Finally, ICPO supports EE (especially regarding water heaters, which ICPO states have proven successful in other programs

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[1223] *Id*. at pages 39-40.

[1224] *Id*. at page 41.

[1225] Empire Gas Company, Inc., Final Brief, March 6, 2020, pages 6-8.

[1226] ICPO, Prefiled Testimony of Mr. Gerardo Cosme Núñez, October 23, 2019, page 3.

[1227] *Id*. at page 4.

[1228] ICPO Final Brief, March 6, 2020, pages 9-11.

[1229] *Id*. at pages 5-6.

[1230] *Id*. at pages 10-11.

[1231] *Id*. at pages 6-7.

[1232] *Id*. at page 10.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

in Puerto Rico) and DR, and the future integration of the IRP with an Integrated Distribution Resource Plan.[1233]

801. In its Reply Brief, ICPO reiterates its support for distributed (rooftop) renewable generation, especially as these resources are not yet deployed at levels that should be critical for grid operations.[1234] ICPO further suggests that utility solar facilities be located on already disturbed sites or rooftops, rather than on agricultural land.[1235] ICPO recommends an evaluation of the potential capacity for deployment and integration of rooftop solar PV systems with storage, including the potential for communications to support VPPs.[1236] ICPO expresses skepticism that customers will be willing to give control of their battery resources to PREPA as part of VPPs, because the customers will be concerned about having reliable power in the case of an outage.[1237] ICPO argues that falling storage costs and increased reliability of the grid could mitigate this customer concern.[1238] Regarding hydropower, ICPO suggests the Energy Bureau require PREPA to conduct a modernization study for the existing hydro facilities and evaluate integrating power generation into existing waterworks.[1239]

802. ICPO's Reply Brief also states that ICPO has reviewed the comments submitted by members of the public. The brief conveys ICPO's understanding that the public commenters are not in favor of the new fossil fuel resources reflected in the Proposed IRP.[1240]

6. Local Environmental Organizations

803. In his Direct Testimony, Mr. Ronny Sandoval provides observations regarding the Proposed Action Plan, with focus on resilience planning and MiniGrids. He testifies that the MiniGrid investments in the Proposed Action Plan completely bypass the Energy Bureau's stakeholder efforts in the Resilience Working Group of the Distribution System Planning process.[1241] He states that "[w]ithout developing a common understanding with stakeholders on how to measure progress towards achieving resilience, examining the conditions one is trying to become resilient against, etc., it's not possible to determine whether the investments proposed truly deliver the most

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[1233] *Id*. at pages 11-13.

[1234] ICPO Reply Brief, April 20, 2020, pages 4-5.

[1235] *Id*. at page 7.

[1236] *Id*. at page 14.

[1237] *Id*. at page 13.

[1238] *Id*. at page 14.

[1239] *Id*. at page 12.

[1240] *Id*. at page 16.

[1241] LEOs, Direct Testimony of Ronny Sandoval, October 23, 2019, page 7.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

effective and sufficiently resilient systems that can be developed."[1242] Mr. Sandoval testifies that one way that resilience differs from reliability is that resilience focuses on the impact to humans as opposed to the performance of the system. As a result, "engaging stakeholders directly on these issues is the only way to ensure the associated human impacts of power disruptions are effectively managed."[1243] Mr. Sandoval identifies particular areas that PREPA should address to transition to an Integrated Distribution Planning paradigm, including forecasting, system modeling, hosting capacity analysis, consideration of non-wires alternatives, and meaningful stakeholder engagement.[1244] Mr. Sandoval also suggests that PREPA's performance be tracked on metrics related to resilience and customer engagement.[1245]

804. Regarding MiniGrid investments, Mr. Sandoval further states that the Action Plan should "account for the ability of systems that are already online [installed by PREPA customers] to meet their own resilience needs in determining how much additional infrastructure PREPA needs to invest in."[1246] He testifies that supporting DER deployment to serve critical loads would also include expediting access to hosting capacity maps, streamlining interconnection processes, and other elements of Distribution System Planning.[1247] Mr. Sandoval suggests that PREPA should consider a "gradual deployment of resilience investments, beginning with areas that have generation resources already in place and may require comparatively lower incremental investments in transmission infrastructure."[1248] He identifies the San Juan area as a place to start MiniGrid investments. Other areas, he states, may call for an approach based more on microgrids than MiniGrids.[1249]

805. In their Final Brief, the LEOs urge the Energy Bureau to reject the Proposed Action Plan because:

- PREPA overestimated the cost of DG and utility-scale solar PV;[1250]

[1242] *Id*. at page 8.

[1243] *Id*. at page 9.

[1244] *Id*. at pages 23-30.

[1245] *Id*. at pages 33-34.

[1246] *Id*. at page 10.

[1247] *Id*.

[1248] *Id*. at page 15.

[1249] *Id*.

[1250] LEOs, Final Brief, March 6, 2020, pages 10-14.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

- PREPA failed to account for the ability of renewables and storage to provide resiliency, and thereby included fixed unneeded thermal resources in its MiniGrid proposal;[1251]
- PREPA proposes reserve margins that are higher than necessary, and thereby creates higher costs;[1252]
- The Proposed IRP's treatment of EE is insufficient,[1253] and if loads are higher than the base case, the ESM plan fails to meet the RPS requirements of Act 17;[1254]
- The Proposed IRP does not include the impact of electric vehicles;[1255] and
- The Proposed Action Plan does not include specific plans to deploy solar PV at the pace envisioned in the Proposed IRP.[1256]

806. The LEOs further urge the Energy Bureau to reject the Action plan's proposal to spend $3.8 billion for transmission to support the MiniGrids concept. They argue that this conclusion is supported by the evidence indicating a lack of certainty regarding what investments are required;[1257] that the MiniGrids concept has a single point of failure in the thermal resource serving critical loads;[1258] and that PREPA has not engaged with the public or the Resilience Working Group in the Energy Bureau's Distribution System Planning process regarding the MiniGrids concept.[1259]

807. The LEOs state that the Energy Bureau should reject the component of the Action Plan to pursue preliminary permitting and engineering for possible CCGTs at Yabucoa and Mayagüez because these generation options were never selected as an economic option in the Aurora modeling;[1260] maintaining the hedge creates an opportunity cost by taking resources away from adding as much PV as practical, as fast as possible;[1261] and the risk that funds expended on maintaining this hedge would be spent without leading to real

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[1251] *Id*. at pages 16-19,

[1252] *Id*. at pages 19-24.

[1253] *Id*. at pages 24-29.

[1254] *Id*. at page 26.

[1255] *Id*. at pages 29-30.

[1256] *Id*. at page 31.

[1257] *Id*. at pages 35 and 39.

[1258] *Id*. at pages 36-37.

[1259] *Id*. at page 37.

[1260] *Id*. at page 44.

[1261] *Id*. at page 45.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

projects that benefit ratepayers instead of on modular renewable generation that can have a steady rate of successful deployments.[1262]

808. The LEOs' Final Brief suggests actions that the Energy Bureau should include in a modified Action Plan. These include:

- Launch quick-start EE programs (including programs directed at solar water heating and refrigeration);[1263]
- Pursue DR from commercial and industrial customers;[1264]
- Adopt the recommendations of the Energy Bureau's EE working group;[1265]
- Facilitate integration of DG, renewables, and storage through:
  - Automatic interconnection under *Comunicado Técnico 19-02*[1266];
  - Coordination with owners to gain visibility and enable VPPs;
  - Coordination to develop a customer engagement plan; and
  - Incentives for customers to deploy distributed solar and storage systems;[1267] and
  - Investigate non-wire alternatives to MiniGrid investments through the use of microgrids and distributed storage to deliver resiliency.[1268]

809. In the LEOs' Reply Brief, the LEOs address the topics raised by the Energy Bureau on rooftop solar, hydroelectric generation, and VPPs. Regarding rooftop solar, the LEOs reiterate the suggested actions in their Final Brief and add a recommendation to open a docket to examine options to finance DG.[1269] The LEOs state that with these actions in place, Puerto Rico could achieve the goals of the *Queremos Sol* proposal (75% of homes to have rooftop solar of about 1.5 kW accompanied by 10 kWh of energy storage by 2035).[1270] Regarding hydroelectric generation, the LEOs support a study for the

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[1262] *Id*. at page 46.

[1263] *Id*. at page 27.

[1264] *Id*. at page 29.

[1265] *Id*. at page 28.

[1266] PREPA, *Comunicados y Circulares Técnicos*, 2019.
https://aeepr.com/es-pr/Site-Servicios/ComunicadosTecnicos/Comunicados%20Tecnicos%202019.pdf

[1267] *Id*. at pages 31-34.

[1268] *Id*. at page 40.

[1269] LEOs, Reply Brief, April 20, 2020, page 5.

[1270] *Id*.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

potential to rehabilitate existing hydroelectric plants as well as the potential to use newer micro-hydro technology to create distributed facilities.[1271]

810. Regarding VPPs, the LEOs express general support for aggregation as a way to capture the value to the electric system from customer-initiated systems.[1272] They emphasize that the procurement processes for VPP aggregators are important, and urge the Energy Bureau to ensure that its Regulation 8815 is followed.[1273] The LEOs state that transparency regarding grid needs is important to enable potential respondents to develop novel and efficient proposals.[1274] The LEOs express concern that aggregation should not be the only solution for DG, since lower-income Puerto Ricans require a different model to be able to afford solar and storage.[1275] The LEOs state that PREPA must create programs to bring the benefits of DG to low-income communities.[1276]

7. Not-for-Profit Intervenors

811. In his Direct Testimony, Mr. Eric Ackerman testifies that the Action Plan should address Advanced Grid Planning methods (also known as Integrated Distribution Planning and Integrated Grid Planning).[1277] He states that these methods use "bottoms-up" analyses to evaluate loads at the distribution circuit level, use new tools to simulate power flows on the distribution grid, and evaluate hosting capacity and multiple DER growth scenarios.[1278] He further states that these methods evaluate the costs and benefits of new DER applications based on their location on the grid, and would allow PREPA to optimize the use of DERs for increased reliability and resilience for critical loads.[1279] Mr. Ackerman states that three tasks should be added to the Action Plan to utilize Advanced Grid Planning: 1) conduct an audit to review PREPA's planning capabilities in relation to what would be required to implement Advanced Grid Planning, identify the resources required, and develop a multi-year plan for introducing Advanced Grid Planning; 2) conduct training to increase understanding of Advanced Grid Planning and the software tools required to implement it; and 3) create a user group with participants from Hawaii, California, and Puerto Rico to share information and

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[1271] *Id*. at page 7.

[1272] *Id*. at page 8.

[1273] *Id*. at page 9.

[1274] *Id*. at page 10.

[1275] *Id*. at pages 8-9.

[1276] *Id*. at page 11.

[1277] Testimony of Mr. Eric Ackerman, October 22, 2019, page 12.

[1278] *Id*. at page 13.

[1279] *Id*.

solutions.[1280] Mr. Ackerman concludes that until advanced grid planning methods have been implemented to guide investment, the Energy Bureau should require PREPA to revise its approach to MiniGrids and approve only minimal investment in GTs and LNG supply infrastructure.[1281]

812. Mr. Ackerman also testifies that the Proposed Action Plan should address a comprehensive strategy for customer engagement including using a customer collaborative on engaging prosumers, and provides a list of potential elements for a strategy for empowering customers that includes compensation for ancillary service, the use of advanced meters, streamlined interconnection, and expanding EE and DR programs.[1282]

813. In his Supplemental Testimony, Mr. Ackerman states that the Proposed Action Plan should be enhanced to implement a "comprehensive strategy for customer engagement" in order to acquire EE, which is likely to be the most economic source of supply in light of a bankruptcy-related risk premium that would be associated with supply-side investments.[1283] He states that customer engagement should include extensive customer education about cost-effective options for EE and DR, and that PREPA and the Energy Bureau should consider using incentives and on-bill financing to encourage customer participation in EE and DR programs.[1284]

814. In his Direct Testimony, Mr. José Alemán testifies that hydroelectric generation should be prioritized over natural gas generation in the Proposed IRP because it costs less and provides additional benefits as a baseload and black-start resource.[1285] He further testifies that the Energy Bureau should require PREPA to conduct analysis and evaluations of hydroelectric resources including the costs of overhauling and repair of existing units (including non-operational units), and require PREPA to develop a specific and detailed action plan for each hydroelectric site.[1286]

815. In their Closing Argument and Brief, the NFPs argue that the Energy Bureau approach the Action Plan knowing that it will need to provide continuing oversight and review plans multiple times between now and 2038.[1287] The NFPs suggest four areas to enhance the IRP Action Plan: (1) implement Advanced Grid Planning, (2) engage

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[1280] *Id*. at pages 15-17.

[1281] *Id*. at page 24.

[1282] *Id*. at pages 17-19.

[1283] Supplemental Testimony of Eric Ackerman, December 10, 2019, pages 3-4.

[1284] *Id*. at page 4.

[1285] Testimony of Mr. José Alemán, October 22, 2019, pages 8-10.

[1286] *Id*. at pages 10-11.

[1287] NFPs, Closing Argument and Brief, March 6, 2020, page 17.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

customers; (3) process interconnection requests; and (4) revisit the strategy for critical facilities.[1288] Across these areas, the NFPs argue for the use of analytical tools, learning from approaches used elsewhere, and using collaboratives or user groups. They also state that the Energy Bureau should approve the amount of energy supply needed, and its required characteristics, but not specific technologies.[1289] Regarding hydropower, the NFPs reiterate Mr. Aleman's conclusions and argue that an IRP that does not include specific plans for hydroelectric facilities deprives the island of an important renewable energy resource that could also provide system reliability and resilience for the central mountain areas where the most socioeconomically vulnerable people in Puerto Rico live.[1290]

8. Progression Energy

816. In his Direct Testimony, Mr. Kevin Banister testifies that PREPA should conduct further analysis of offshore wind, and that the Action Plan should include up to 500 MW of offshore wind.[1291]

9. Solar and Energy Storage Association – Puerto Rico

817. In its Reply to Final Briefs, SESA-PR recommends that the process to develop the next IRP begin earlier, relative to the expected date of completion, and be developed collaboratively with stakeholders.[1292] SESA-PR also identifies portions of other parties' final briefs with which it agrees; these parties' positions are summarized in the appropriate portions of this Part.

10. Sunrun

818. In his Direct Testimony, Mr. Christopher Rauscher testifies that VPPs must be explicitly procured, even if the component resources have been deployed "autonomously" by customers.[1293] In particular, he testifies that VPPs must be procured in advance of other resources in order to serve the purpose of displacing or reducing the need for those other resources.[1294] Mr. Rauscher further testifies that PREPA would not need direct communications with each component of a VPP.[1295] Instead, PREPA could communicate

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[1288] *Id*. at page 18.

[1289] *Id*. at page 19.

[1290] *Id.* at pages 19-20.

[1291] Prefiled Testimony of Kevin Banister, October 23, 2019, lines 266-268 and 277.

[1292] SESA-PR, Reply to Final Briefs, April 20, 2020, page 2.

[1293] Pre-Filed Testimony of Mr. Christopher Rauscher, October 23, 2019, page 9.

[1294] *Id.*

[1295] *Id.* at page 15.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

with an aggregator, which in turn would have independent communication with the components through cellular or customer Wi-Fi connections.[1296] He states that PREPA would not need to make any changes to billing, rate structures, or customer communications, because the aggregator manages those aspects of the VPP-participant relationship (including sharing the income from any payments that PREPA makes for the performance of the VPP).[1297]

819. In its Final Brief, Sunrun argues that the Proposed IRP must include VPPs as a "first-decision, no-regrets solution, and thus inform near-term PREPA resource procurement actions."[1298] Sunrun surveys statutory mandates related to the IRP and DG, including particularly in Act 17, to provide support for the IRP to include actions in support of VPPs.[1299] Sunrun emphasizes the importance of the IRP Action Plan in guiding expected procurement, as described in Regulation 9021.[1300]

820. The Energy Bureau specifically requested that Reply Briefs address VPPs.[1301] In its Reply Brief, Sunrun proposes two potential approaches for VPP procurement.[1302] The first is referred to as "utility offtake" and would consist of making the rooftops of public buildings (with a minimum average roof size of 10,000 sq. ft.) available for a $0 roof rental agreement, in exchange for backup power in the buildings. PREPA or the bidder would set the ratio of energy storage to the energy generated, PREPA would either compensate the bidder for a combined energy and capacity product, or for the two services separately. The second potential approach is to procure capacity from projects participating in net energy metering. In either case, Sunrun proposes that bidders be invited to submit bids in units of 10 MW, up to 300 MW.[1303] Sunrun further describes several approaches to VPPs as operating in the U.S., including "bring your own device" programs,[1304] and argues that the Energy Bureau should integrate and adopt proven approaches to VPPs in the Action Plan.[1305]

[1296] *Id.*

[1297] *Id.* at pages 16-17.

[1298] Sunrun, Final Substantive Brief, March 6, 2020, page 2.

[1299] *Id.* at pages 10-11.

[1300] *Id.* at pages 11-12.

[1301] Resolution and Order, In Re: Review of the Puerto Rico Electric Power Authority Integrated Resource Plan, Case No. CEPR-AP-2018-0001, March 3, 2020, on the topics identified during the Public Comment Process that the parties must address in their Reply Briefs.

[1302] Sunrun, Brief in Compliance with Order, April 20, 2020, page 2.

[1303] *Id*. at page 1.

[1304] *Id*. at page 4.

[1305] *Id*.

11. Wärtsilä

821. In its Final Brief, Wärtsilä recommends that the Energy Bureau treat the Proposed IRP as a roadmap, and that any resulting RFP should be as broad as possible.[1306]

12. Amicus Curiae

a. Rocky Mountain Institute

822. In its Amended Brief, RMI addresses the inclusion in the Action Plan of the preliminary permitting and engineering activities for LNG terminals and gas generation in Mayagüez and Yabucoa. RMI argues that pursuing such preliminary activities is "particularly questionable given that limits on PREPA's internal capabilities are cited as justification for reducing the pace of solar PV acquisition."[1307] RMI argues that directing limited resources toward facilities that may never be built represents a "significant opportunity cost" because it could limit the capacity available to integrate solar and storage into the energy system.[1308] RMI states that the Energy Bureau should not approve LNG or gas generation at Mayagüez or Yabucoa, and should restrict PREPA's ability to use limited staff resources on such projects.[1309] Regarding Palo Seco, RMI urges the Energy Bureau to scrutinize the justification for such a facility due to the fact that cases without Palo Seco are comparable in cost and solar costs may be lower than assumed in the Proposed IRP. RMI directs the Energy Bureau's attention to case S3S2S8, which offers comparable costs to S4S2 while providing a more direct transition to 100% renewable energy and limiting stranded cost risk.[1310] RMI further argues that dismissing S3S2S8 because it is a major change from the status quo (by shifting away from thermal resources) is not justified because the Proposed IRP modeling shows that S3S2S8 satisfies demand and Puerto Rico will eventually require retirement of all non-renewable thermal generation.[1311]

823. Regarding distributed resources and VPPs, RMI argues that the Energy Bureau should established clear procurement guidelines so that distributed resources are not unduly excluded.[1312] This includes not setting minimum bid sizes too large and avoiding

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[1306] Wartsila North America, Inc., Final Substantive and Legal Brief, March 6, 2020, pages 1-2.

[1307] Rocky Mountain Institute, Amended *Amicus Brief*, December 20, 2019, page 16.

[1308] *Id*.

[1309] *Id*.

[1310] *Id*. at page 17.

[1311] *Id*. at page 18.

[1312] *Id*. at page 23.

improper technical requirements.[1313] RMI cites projects of much less than 10 MW in capacity.

C. PREPA Rebuttal and Briefs

824. In his Rebuttal Testimony for PREPA, Dr. Bacalao responds to Mr. Moe's concern (in testimony for AES-PR) that capital may not be available to PREPA in the amount and cost that was assumed in the IRP. Mr. Bacalao states that the risk that capital will not be available, or be too costly, exists in all of the scenarios in the IRP.[1314] However, he argues that for planning purposes it is reasonable to assume that capital is available because to make any other assumption would "essentially freeze the planning process in place, which would render the integrated resource planning process an entirely meaningless exercise."[1315]

825. In its Final Brief, PREPA largely reiterates the basis for recommending the Proposed Action Plan that is laid out in the IRP itself. In particular, PREPA states that it believes the Proposed Action Plan provides the "most robust approach to transforming Puerto Rico's electric generation resource mix and accelerating renewables penetration toward the goal of achieving compliance with the energy policy goal of 100% renewables."[1316] PREPA reiterates its support for the development of "hedges" in the form of natural gas generating facilities that can be developed and constructed, if necessary, to address shortfalls in other generation sources. In its brief, PREPA also provides a history and justification for the ESM Plan that is not presented as a single story elsewhere in the IRP or PREPA's testimony. PREPA describes that the ESM Plan reflects collaboration with experts led by the Central Office for Recovery, Reconstruction, and Resiliency (COR3).[1317] COR3 published an ESM Plan in February 2019,[1318] but it was under development in time to inform scenario development for the IRP in November 2018.[1319] PREPA modeled an ESM scenario as a modified version of the S4S2 scenario, with additional fixed decisions.[1320] The ESM scenario has subsequently been adjusted to account for the passage of Act 17, increased reliance on DG, and increased EE, among other changes.[1321] PREPA explains that the Action Plan,

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[1313] *Id*.

[1314] Rebuttal Testimony of Nelson Bacalao, December 20, 2019, page 14.

[1315] *Id*.

[1316] PREPA, Final Brief, March 6, 2020, page 26.

[1317] *Id*. at pages 28-29.

[1318] *Id*. at page 30.

[1319] *Id*. at page 31.

[1320] PREPA Workpaper, "Considerations on the ESM Plan.docx", page 1.

[1321] PREPA, Final Brief, March 6, 2020, page 32.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

based on the ESM Plan and ESM scenario, is designed to retain flexibility to account for gaps between supply and demand by developing generation resource opportunities and then only constructing them, "…if load deviates from the Proposed IRP's forecast or renewable generation and storage resources are not actually available to the extent required to satisfy the load."[1322]

826. PREPA's Reply Brief addresses numerous topics raised by intervenors, and in response provides further clarity regarding PREPA's position on topics relevant to the Proposed Action Plan, including practical limits to the pace of deployment of solar PV and battery energy storage; reliance on gas generation, the value of "hedges" and the merits of the Proposed Action Plan compared with the S3S2S8 and S4S2S9 scenarios favored by some intervenors; the appropriate planning balance between distributed rooftop PV systems and utility-scale generation; the role of VPPs; and transmission investments to support MiniGrids.

827. Regarding limits on the pace of deployment for solar PV and BESS, PREPA argues that the Action Plan includes adoption of these resources at a pace that will meet all legal requirements, including the RPS.[1323] PREPA emphasizes that the Proposed Action Plan would "reflect the most rapid deployment of renewables, battery energy storage and DG judged to be feasible."[1324] PREPA argues that other parties have not presented evidence that limits used in the development of the Action Plan are unreasonable, nor that PREPA does not face some constraint in the pace at which resources can be added.[1325] PREPA concludes that observing the annual limits "will not inhibit PREPA from achieving a rate of integration of renewable and battery energy storage systems that has never been achieved before."[1326]

828. Regarding reliance on gas generation and the value of maintaining "hedges," PREPA argues that "[g]oing the route of not engaging in early pre-development and permitting efforts for the Yabucoa and Mayagüez gas-fired facilities would leave PREPA exposed to the responsibility of dealing with higher load by running inefficient and costly generation, or by contracting for the installation of more renewable generating capacity than would be economic."[1327] PREPA further states that using S3S2S9 or S4S2S9 (as modified by EDF and OPIC in their briefs) would "foreclose development of a large generating resource in the north, at Palo Seco, near the San Juan load center, which PREPA and the U.S. Department of Energy believe would be critically important to the

[1322] *Id*. at page 33.

[1323] PREPA, Reply Brief, April 20, 2020, page 17.

[1324] *Id*. at page 19.

[1325] *Id*. at page 17.

[1326] *Id*. at page 22.

[1327] *Id*. at page 34.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

maintenance of service in the north during and following weather events that impact long-distance transmission lines."[1328] PREPA assures the parties and the Energy Bureau that "the approval of the Action Plan, as submitted to the Energy Bureau, would not give PREPA authorization to enter unilaterally into individual generation resource procurement contracts, should the right conditions arise; as per applicable regulations and law, the Energy Bureau is the entity that must review and authorize each PREPA decision to solicit and contract for particular generation resources."[1329]

829. Regarding the portfolio balance between rooftop and utility-scale resources, PREPA argues that it cannot plan based on the "hope" that rooftop solar and storage systems will be developed at the pace required to meet Puerto Rico's need for solar energy and capacity.[1330] PREPA identifies that the LTCE models runs conducted for the IRP include the impact of substantial amounts of DG, EE, and DR, yet show that there is a remaining need for large amounts of utility-scale renewable generation and smaller amounts of gas-fired generation.[1331]

830. Regarding VPPs, PREPA's Reply Brief states that "if appropriately documented VPP arrangements are offered in resource solicitations contemplated by the Proposed IRP, and can be shown to be dependable and competitive with utility-scale resources, there is no reason why PREPA wouldn't select them."[1332]

831. Regarding transmission investments to support the IRP's MiniGrid proposal, PREPA points out that the identified transmission investments would allow utility-scale generation to serve local load in the aftermath of a major event.[1333] PREPA reiterates that the value of lost load analysis presented in the Proposed IRP shows that if the MiniGrid proposal were to prevent lost load for a period of a few weeks, the investment would be justified. Regarding the need for thermal generation to supply critical loads, PREPA states that in the event that renewable and storage resources that could be "available when needed," using these resources instead of thermal sources "is not precluded under the Preferred Resource Plan or Action Plan."[1334]

[1328] *Id*. at page 36.

[1329] *Id*. at page 51.

[1330] *Id*. at page 10.

[1331] *Id*. at page 24.

[1332] *Id*. at page 10.

[1333] *Id*. at pages 38-39.

[1334] *Id*. at page 9.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

D. Discussion

832. Regulation 9021[1335] describes the documentation and development requirements for an Action Plan. It states that the Action Plan shall be based on the Preferred Resource Plan and shall cover no less than a five-year period from the date of the Proposed IRP filing. The Action Plan shall include a table of key actions including expected procurement processes and intended acquisitions of demand-side, supply-side, transmission, distribution, and fuel infrastructure resources. It shall also include retirements or retrofits of existing generation resources, entry into or cessation of power purchase agreements and any other resource commitments. The Modified Action Plan described below contains those actions.

1. PREPA's Preferred Resource Plan

833. PREPA proposed the ESM Scenario as its Preferred Resource Plan. The Energy Bureau **DOES NOT APPROVE** PREPA's Preferred Resource Plan, as discussed in Part III(G). Part III(G) found that a greater reliance on solar PV and battery resources and a faster installation pace of those resources, and a lesser reliance on new gas resources, was a lower cost resource plan using the net present value of revenue requirements. The Energy Bureau **FINDS** that increased deployment of solar PV and battery resources should be pursued if the results of procurement processes produce costs that reflect the parameters associated with Scenario S3S2 (for all loading levels under that Scenario) and if those resources are available for faster installation than was assumed for PREPA's ESM Plan.

834. The Energy Bureau **FINDS** that a Modified Preferred Resource Plan for the purpose of initial procurement planning includes the solar PV and battery energy storage quantities contained in Scenario S3S2B for the first five years of the Action Plan period. The Energy Bureau **FINDS** that, for the purpose of determining the overall renewable energy resource installation goals for the PREPA system, the Modified Preferred Resource Plan includes the level of DG directly modeled as an input in all of PREPA's resource scenarios. The Energy Bureau **FINDS** that these quantities in total reflect the overall installation goals for the PREPA system, to be met through a combination of direct procurement, described herein through competitive RFP processes; existing PPOAs under re-negotiation; and through customer provision under the different options available to customers to provide their own energy. Table 16 below summarizes these quantities, indicating a range of renewable energy and battery energy storage resources to serve as upper and lower bounds when considering overall procurement levels around which PREPA will formulate a procurement plan. These upper and lower bounds are formed by the results of PREPA's modeling of "Full EE" and "Low EE" baseload levels, and reflect the solar PV and battery energy storage

[1335] *See* Regulation 9021, §§ 2.03 (K) (1) and (2).

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

additions seen in 2025 in Appendix C Table C-5, which is from PREPA's response to Energy Bureau ROI-10-5 and reflects the annual installation pattern seen in PREPA's metric files for these Scenarios.

Table 16. Overall Installation Guidance for Modified Preferred Resource Plan

Scenario	Quantity Range	2019	2020	2021	2022	2023	2024	2025
Scenario S3S2B Full EE (ROI-10-5) Solar PV, MW	Lower Bound	-	300	900	1,500	2,100	2,700	3,060
Scenario S3S2B Low EE (ROI-10-5) Solar PV, MW	Upper Bound	-	300	1,020	1,740	2,460	3,180	3,540
All Scenarios Customer-owned Solar PV, MW		208	273	310	339	368	397	428
Total Solar, S3S2B Full EE, MW	Lower Bound	208	573	1,210	1,839	2,468	3,097	3,488
Total Solar, S3S2B Low EE, MW	Upper Bound	208	573	1,330	2,079	2,828	3,577	3,968
Battery Energy Storage, Full EE, MW	Lower Bound	40	240	840	1,160	1,360	1,360	1,360
Battery Energy Storage, Low EE, MW	Upper Bound	40	240	840	1,160	1,360	1,400	1,480

Note: "Total Solar" is the sum of customer-owned solar DG, and the amount of solar PV from the Scenario modeling result.
Source: PREPA response to Energy Bureau ROI-10-5, S3S2B capacity additions; IRP Appendix 4, DG solar installations.

835. The Modified Preferred Resource Plan is based on Scenario S3S2B. The Modified Preferred Resource Plan i) contains an increased level of solar PV and battery resources relative to PREPA's ESM Scenario, ii) excludes the need for a new combined cycle unit at Palo Seco, and iii) excludes the new peaking resources included in PREPA's plan as a fixed decision. It includes EE resources as modeled in PREPA's baseload forecast scenarios.

2. Modified Action Plan

836. In accordance with the findings and determinations contained in this Final Resolution and Order, and as discussed below in this Part, the Energy Bureau **MODIFIES** PREPA's Proposed Action Plan. The Modified Action Plan is premised on a modification to PREPA's Preferred Resource Plan and the ESM Scenario, based on the rationale set out in Part III(G) of this Final Resolution and Order.

837. In accordance with the findings and determinations contained in this Final Resolution and Order, and as discussed below in this Part the Energy Bureau **DOES NOT APPROVE** PREPA'S Proposed Action Plan as presented and **MODIFIES** the Proposed Action Plan. The Modified Action Plan is premised, first, on a modification to PREPA's Preferred Resource Plan, and the ESM Scenario, because of the reasoning set out in Part III(G) of this Final Resolution and Order. This includes an increased level of renewable energy as set forth in Table 16 above. The Modified Action Plan shall be in effect for five years from the date of the issuance of this Final Resolution and Order, unless otherwise ordered by the Energy Bureau.

838. The Modified Action Plan depends on a combination of transmission system hardening and distributed resource deployment to ensure a resilient power system, in addition to PREPA's plans for distribution system hardening. The Energy Bureau **ACCEPTS** the MiniGrid **concept** as a mechanism to provide resiliency during the loss of transmission or distribution system operations due to severe weather. The body of evidence from numerous intervenors in this proceeding, including that of Sunrun, LEOs, NFP intervenors, and RMI, confirms the viability of distributed resources to provide resiliency in the face of loss of transmission or distribution system operations due to severe weather.[1336] PREPA confirmed its understanding that smaller distributed resources could provide support for resiliency requirements.[1337] Therefore, the Energy Bureau **DOES NOT ACCEPT** thermal generation as the only resource to be used to meet critical loads in MiniGrid regions.

839. PREPA acknowledges that "further optimization" is required for transmission system needs as part of its MiniGrid approach.[1338] In large part because of this lack of optimization, the Energy Bureau **DISAPROVES**, at this moment, the expenditure of $5.9 billion on transmission investment for the MiniGrid approach, as proposed by PREPA. The Energy Bureau **FINDS** that it is necessary to commence a separate proceeding to determine the optimal level of additional transmission hardening, beyond hardening of certain existing assets as described in Part III(I) of this Final Resolution and Order. In this separate proceeding the Energy Bureau will evaluate the intersection of resiliency provisions with more transmission hardening expenditures in (initially) one or two MiniGrid regions; and resiliency provisions through deployment of local, distributed resources. Local distributed resources can provide resilience and reduce transmission costs otherwise associated with PREPA's proposed MiniGrid approach. The Energy

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[1336] For example, see Direct Testimony of Christopher Rauscher of Sunrun, pages 4-5; Direct Testimony of Ronny Sandoval for the LEOs at pages 13-21; Direct Testimony of Eric Ackerman for the NFP intervenors, pages 17-19; and RMI *Amicus Curiae* Brief at pages 3, and 20-24.

[1337] PREPA's Response to NFP's ROI 1-1 and 1-2, September 11, 2019, indicating that customer resources could contribute to meeting critical and priority load. PREPA Final Brief, indicating PREPA would select VPPs if appropriately documented and competitive with utility-scale resources. Page 10.

[1338] Testimony of Dr. Bacalao, Evidentiary Hearing, February 5, 2020, morning session, circa 00:10.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Bureau **FINDS** that local distributed resilience provisions include microgrid establishment or support and include energy and capacity provision by customers or prosumers.

840. PREPA 's placement of customers as central to its plan[1339] must allow for those customers to compete to provide energy supply from distributed resources as part of the resources available to operate after a severe storm. The Energy Bureau **FINDS** that customer-provided energy makes up a portion of local distributed resilience provision.

841. This Modified Action Plan consists of specific directives to PREPA, including the following key components:

- Development by PREPA, with Energy Bureau guidance, of a detailed procurement plan for renewable resources and battery energy storage to achieve compliance with the RPS;
- Establishment of a new proceeding to explore how best to optimize potential transmission system expenditures in support of the MiniGrid concept if and where it would be most valuable and cost-effective for customers. This proceeding will include assessment of distributed resource resiliency complementary to potential MiniGrid transmission investments;
- Determination of retirement schedules for older oil-fired generating units (with approval of conversion of some units to synchronous condensing operation), which will be dependent on achieving specific reliability milestones: completion of new battery energy storage capacity, potential additional other peaking capacity, and obtaining DR resources and peak load reduction through EE provision;
- Determining the sequence of efforts required and allowed with respect to how PREPA conducts preliminary permitting and engineering for utilization of the Palo Seco site for generation, storage, or other uses. This action shall not in any way delay the completion of the first RFP issuance for renewable energy and battery energy storage resources;
- Establishing EE programs that grow from initial quick-start programs to aggressive and comprehensive approaches;
- Enabling of DR;
- Conditional approval of certain non-MiniGrid aspects of PREPA's T&D planning;
- Disapproval of certain "fixed decision" generation resource inclusions in PREPA's Proposed Action Plan.

[1339] *See* Proposed IRP, page 1-1, "Customer-centric".

- Disapproval of related LNG infrastructure inclusions in PREPA's Proposed Action Plan.

842. The Energy Bureau hereby describes actions that PREPA shall take over the next five (5) fiscal years in accordance with Regulation 9021.[1340] This Modified Action Plan will remain in place until another Action Plan is approved by the Energy Bureau.

3. Energy Bureau Directives as to Process and Approvals

843. The Energy Bureau's inclusion of specific actions or investments in this Modified Action Plan does not constitute pre-approval of those actions or investments by the Energy Bureau, nor is PREPA guaranteed recovery of costs related to those actions or investments. PREPA must file with the Energy Bureau specific requests, whether in a rate case or other proceeding, for approval of individual actions and investments. Such requests must be accompanied by the corresponding documentation and analysis.

844. For many of the directives listed below, PREPA must file with the Energy Bureau detailed information, such as progress reports, and, when required, draft RFPs, pursuant to the applicable regulations. PREPA must comply with the terms and conditions of applicable regulations when conducting any competitive procurement processes performed to comply with the provisions of this Final Resolution and Order. The Energy Bureau will exercise its powers to review and guarantee that PREPA undertakes a competitive procurement process which fully complies with the goals and objectives of the Modified Action Plan, this Final Resolution and Order and all applicable laws and regulations related to procurement processes. All competitive bidding processes shall conform to the objectives and directives set forth herein.

845. According to the above, the Energy Bureau will provide a deadline for each of the reports or submissions requested. If PREPA finds that it is unable to meet any of the deadlines, PREPA shall timely provide notice to the Energy Bureau no less than 10 business days prior to the deadline. Any such notice shall include a justification for the delay and a reasonable proposal for a new deadline.

846. A summary table of the Modified Action Plan is provided at the end of this Part.

4. Supply Resources

a. New renewable resources and battery storage

847. The Energy Bureau **ORDERS** PREPA to issue a series of new RFPs for provision of renewable energy in support of Act 82's RPS goals, and for the provision of battery energy storage in support of capacity requirements needed to meet PREPA's peak load

[1340] *See* Regulation 9021, § 203(K)(2)(b). Actions that PREPA would take after FY-2025 are not discussed in this Modified Action Plan.

requirements and in support of integration requirements for renewable energy generation. The quantities of procured renewable energy and battery energy storage associated with the RFPs will reflect the overall renewable energy and storage needs reflected in the Modified Preferred Resource Plan and ultimately account for existing renewable resources, renewable resources from re-negotiated PPOAs, and newly installed renewable resources in future years.

848. As noted in Part III(B) above, the Proposed IRP Scenarios S3S2B and S4S2B reflected levels of solar PV and battery storage capacity based on a full level of EE incorporated into the forecast load.

849. The S3S2B and S4S2B Scenarios both show an even higher level of solar PV and battery energy storage capacity as a result of the LTCE modeling runs, for loading levels that are higher because of a reduced level of EE modeled in PREPA's Response to Energy Bureau's ROI 9-1 and ROI-10-5. Appendix C, Tables C-4 and C-5 show the resource addition results from PREPA's LTCE modeling in PREPA's Response to Energy Bureau's ROI 9-1 and ROI 10-5 (respectively).

850. By 2025, S4S2B solar PV installations range from 2,580 MW to 3,300 MW across all loading scenarios (and up to 4,680 MW if there are no limits placed on solar PV installation rates); and S3S2B solar PV installations range from 3,060 MW to 3,900 MW across all loading scenarios (and up to 5,220 MW if there are no limits placed on solar PV installation rates).

851. By 2025, S4S2B battery energy storage installations range from 1,360 MW to 1,520 MW across all loading scenarios (and up to 2,000 MW if there are no limits placed on battery energy storage installation rates); and S3S2B battery energy storage installations range from 1,360 MW to 1,640 MW across all loading scenarios (and up to 1,720 MW if there are no limits placed on BESS installation rates).

852. By 2038, the level of solar PV and battery energy storage installations increase across all Scenarios, and under any of the loading levels. For S3S2B, under the "low EE" loading level, solar PV installations by 2038 are 5,640 MW, and battery energy storage installations reach 3,040 MW.

853. In describing the modeling results from the Energy Bureau's Ninth ROI, PREPA states:

> All plans have similar levels of Solar PV installed by 2025 reaching very close to the limits by year and installing over 3,000 MW of photovoltaics. This is a clear indication of the adequacy of maximizing the rate of adoption of this generation.[1341]

[1341] PREPA's Response to Energy Bureau's ROI-09-01, page 12, December 2, 2019.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

854. PREPA states that including installation of renewable energy and battery storage is a "no regrets" action required as a result of the Proposed IRP.[1342]

855. The Energy Bureau agrees that the installation of renewable energy and battery storage is a "no regrets" action and **FINDS** that maximizing the rate of adoption of solar PV and battery storage technology is clearly indicated from the modeling results of the Proposed IRP. The Energy Bureau **FURTHER FINDS** in favor of this "no regrets" action and **ORDERS** that the goal of maximizing the rate of solar PV installations and battery storage in Puerto Rico be achieved as part of the Modified Action Plan.

b. Competitive procurement process

856. PREPA's plans to install the required renewable resources, in the form of solar PV and battery energy storage resources, are premised on competitive procurement through issuance of new RFPs.[1343] Sunrun's witness Mr. Rauscher testified to the ability of distributed solar and battery resources, in the form of VPPs to provide the energy and storage services that could otherwise be provided by utility-scale solar PV and battery energy storage.[1344] Other intervenor witnesses also testified to, or expressed in briefing, the ability of distributed resources to provide both energy and capacity for PREPA's needs, in addition to potentially providing resiliency benefits.[1345] PREPA agreed that as long as PREPA has visibility into the DG or battery storage,[1346] and the characteristics of the distributed resource are comparable to those provided on a utility-scale, there is no reason it cannot compete with utility-scale resources for provision of energy and storage capacity.[1347] PREPA has stated that it intends for all new generation additions to be procured as PPOAs.

857. Act 17 requires PREPA to reach a renewable portfolio level of 40% by 2025. Act 17 supports installation of energy storage capacity to allow for increases in renewable resource installations.[1348] Act 17 also supports promotion of distributed resources to provide needed energy and capacity, and potentially resiliency in the form of microgrid resources or stand-alone points of resiliency. The resources to meet these requirements include solar PV, but also include wind and hydropower and any other

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[1342] Evidentiary Hearing, Testimony of Dr. Bacalao, February 7, 2020, morning session, 01:20.

[1343] *See* Proposed IRP, pages 10-2 to 10-3.

[1344] Direct Testimony of Mr. Rauscher, page 4.

[1345] Prof. Irizarry-Rivera, pages 27-28; Dr. Stanton, page 25; Dr. Woychik, pages 6, 9, and 11-13; Mr. Ackerman, pages 10-12; Mr. Sandoval, pages 11-17; and RMI Amended *Amicus Brief*, pages 20-24.

[1346] Evidentiary Hearing, Testimony of Dr. Bacalao, February 4, 2020, afternoon session, circa 01: 16. February 6, 2020 morning session, 02:27, 03:40.

[1347] PREPA Final Brief, page 10.

[1348] Act 17 amends Section 6.3 of Act 57, as amended, to include Energy Bureau duties promoting the storage of energy and integration of distributed generation, among others.

renewable energy technologies established under Act 82.[1349] Pursuant to Act 17, all solicitations to obtain renewable energy, capacity, and battery energy storage shall allow participation by all eligible resources. The resources to meet these requirements shall include solar PV, wind, and hydropower.[1350] While the Proposed IRP resource modeling generally did not select wind resources for inclusion in the least-cost plan, PREPA directly confirmed at the Evidentiary Hearing that wind resources would also be able to participate in any renewable energy procurement solicitations.[1351]

858. The Energy Bureau **FINDS** that PREPA's plan to use RFPs to solicit solar PV and battery energy resource capabilities in line with its need for these resources is **ACCEPTABLE**. The Energy Bureau also **FINDS** that competitive procurements to obtain PPOAs for these **resources must be open to all forms of renewable energy, including, but not limited to wind, hydro, solar PV, VPPs, and storage.** The Energy Bureau **FURTHER FINDS** that PREPA should not unnecessarily limit the level of overall procurement to 250 MW blocks, but rather needs to pursue a strategy that attempts to procure the amount of resources required under S3S2B.[1352] As part of a competitive procurement plan PREPA must further describe internal or external staffing resources, constraints, and potential solutions to any constraints, as required, in order to meet the renewable energy and battery storage resource levels in the Modified Preferred Resource Plan.

859. The Energy Bureau **ORDERS** PREPA to develop competitive solicitation processes for procurement of new renewable resources and battery energy storage resources in support of "no regrets" findings for these resources from the IRP and in support of meeting Act 17-2019 targets for renewable energy installations,and exceeding those targets where economical. PREPA or the T&D Operator, with oversight by the Energy Bureau under the processes of Regulation 8815, shall run all competitive auctions in accordance with this Modified Action Plan.

860. The Energy Bureau **ORDERS** PREPA to on or before sixty (60) days from the notification date of this Final Resolution and Order, submit a draft renewable resource and battery energy storage resource procurement plan (Procurement Plan) to the

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[1349] Act 82 defines the term "alternate renewable energy" as the energy derived from the following sources: (a) combustion of gas derived from a sanitary landfill; (b) anaerobic digestion; and (b) fuel cells. *See* Article 1.4 (13) of Act 82. Futhermore, Act 82 defines "sustainable renewable energy" as the energy derived from the following sources: (a) solar energy; (b) eolic energy; (c) geothermic; (d) combustion of renewable biomass; (e) combustion gas derived from renewable biomass; (f) combustion of biofuels derived exclusively from renewable biomass; (g) hydroelectric energy; (h) hydrokinetic and marine renewable energy, as defined in Section 632 of *The Energy Independence and Security Act of 2007*; and oceanic thermal energy. *See* Article 1.4 (15) of Act 82.

[1350] *See* Act 17 § 1.4 (15).

[1351] Evidentiary Hearing, Testimony of Dr. Bacalao, February 5, 2020, afternoon session, circa 03:41.

[1352] As seen in the modeling runs provided in PREPA's Response to Energy Bureau's ROI-10-5, January 22, 2020.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Energy Bureau. The Energy Bureau **FURTHER ORDERS** PREPA to file a status report on the development of its draft Procurement Plan and associated Procurement Plan no later than thirty (30) days from the notification date of this Resolution and Order. PREPA shall include the following information in the draft Procurement Plan:

- A detailed description of the entire Procurement Plan;
- A discussion of how the Procurement Plan considers a means to minimize counter-party risk and thus potentially incentivize bidders to offer lower prices, given PREPA's current financial status. This would include consideration of staging the RFP processes to not lock-in higher prices earlier, if later-staged RFPs can better ensure lower bid prices while still meeting RPS requirements;
- A template for RFPs;
- A template of a PPOA for the provision of energy and dispatchable capacity for sale to PREPA;
- The Procurement Plan must allow for PREPA to choose to select resources for PPOAs in excess of the 1,000 MW minimum (solar PV or energy-equivalent other renewable) or 500 MW minimum (battery energy storage, 4-hour duration equivalent) for either or both renewable energy and battery storage capacity if cost-effective economically and if installation feasibility allows.
- The Procurement Plan may contemplate contracting a lower quantity of resources than the minimum solicitation amount, depending on the responses received.
- The Procurement Plan must indicate the planned installation timeline for resources, based on the estimation of the amount of time required between contracting and installation periods.
- The Procurement Plan must be transparent in communicating the expected timeline of the release of subsequent RFPs to be issued in sequence (*e.g.,* every six months, over the next three years for a total of 6 tranches of RFP releases). The procurement of resources may be front-loaded within the five-year period in order to allow time for construction, interconnections, and commissioning within the five-year Action Plan period.
- The schedule of minimum RFP quantities is as follows, in conformance with target quantities in the Modified Preferred Resource Plan;[1353]

[1353] Subsequent RFP releases are to be designed as necessary to attain contracts for installation of renewable resources and battery energy storage quantities associated with the Action Plan period of the Modified Preferred Resource Plan.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

- **1st Tranche**: at least 1,000 MW solar PV (or energy-equivalent other renewable), at least 500 MW (2,000 MWh or equivalent) battery energy storage.
- **2nd Tranche**: at least 500 MW solar PV (or energy-equivalent other renewable), at least 250 MW (1,000 MWh or equivalent) battery energy storage.
- **3rd Tranche**: at least 500 MW solar PV (or energy-equivalent other renewable), 250 MW (1,000 MWh or equivalent) battery energy storage.
- **4th Tranche**: at least 500 MW solar PV (or energy-equivalent other renewable), 250 MW (1,000 MWh or equivalent) battery energy storage.
- **5th Tranche**: 500 MW solar PV (or energy-equivalent other renewable), 125 MW (500 MWh or equivalent) battery energy storage.
- **6th Tranche**: 750 MW solar PV (or energy-equivalent other renewable), 125 MW (500 MWh or equivalent) battery energy storage.

Table 17. Guidance for Solar PV/Renewables, and Battery Energy Storage RFP Tranches

		Solar PV or equivalent other energy, MW		4-hr. Battery Storage equivalent, MW	
RFP Target Release Date	**Procurement Tranche**	**Minimum**	**Cumulative**	**Minimum**	**Cumulative**
Dec-20	1	1000	1000	500	500
Jun-21	2	500	1500	250	750
Dec-21	3	500	2000	250	1000
Jun-22	4	500	2500	250	1250
Dec-22	5	500	3000	125	1375
Jun-23	6	750	3750	125	1500

861. Quantities of tranches subsequent to the first two tranches may be adjusted if or as necessary to account for installations of DG that contribute to meeting overall quantities in the Modified Preferred Resource Plan, and for resources that PREPA identifies and contracts with in excess of the minimum amounts required in each of the earlier RFPs.

862. The Procurement Plan shall indicate the proposed RFP tranche, and shall include, but not be limited to, the following evaluation parameters:

- Least-cost, energy basis.

- Least-cost, capacity basis. Capacity basis to directly reflect possible provision of ancillary services (frequency response, operating reserve, reactive support) in addition to capacity to meet peak load.
- Recognition of T&D system loss benefits for DG/storage bids.
- Recognition of potential for additional resiliency benefits.
- Estimated timeline for completing installation of resources.
- Technical superiority of location for interconnection purposes.
- Adherence to locational preferences closer to load.
- Locational diversity around the Islands of Puerto Rico in proportion to load, within each MiniGrid region, and especially in MiniGrid regions exhibiting relatively less existing capacity in proportion to existing peak load.

863. PREPA can and should select more than 1000 MW of renewable energy or 500 MW of battery storage capacity resources in response to the initial RFPs if cost-effective, and if the installation pace is feasible, thus accelerating the level of installations that would otherwise arise from subsequent RFPs.

864. Battery energy storage bids can include MW and MWh from existing resources currently not contracted to PREPA, if they meet technical requirements for visibility, control, or other related technical needs.

865. All resources and storage amounts can be aggregates of smaller installations (that is, VPPs are explicitly allowed and must be able to compete on fair terms).

866. Combined or individual bids for renewable generation, battery, or combinations of renewable generation and battery resources are permitted.

867. The Energy Bureau **NOTIFIES** PREPA that explicit performance incentive metrics related to the timeliness and effectiveness of PREPA procurement and interconnection of resources may be included as part of ongoing metrics reporting requirements under Case No. NEPR-MI-2019-0007.

c. Hydro facilities

868. In the Proposed IRP analysis, PREPA assumed that hydropower resources could be refurbished to a capacity of 70 MW, with a capacity factor of 28%, up from current operating levels of 34 MW and 15% capacity factor. However, PREPA did not include any actions related to this refurbishment in its Proposed Action Plan. Mr. Alemán, testifying for the NFPs, provides convincing evidence that further evaluation of PREPA's hydro facilities is prudent and could identify cost-effective renewable resources. The Energy Bureau **ORDERS** PREPA to complete a feasibility study of refurbishing each of its hydroelectric facilities, including the expected cost and likely

change in electricity production, as well as the potential to control production to produce at the times of greatest value in the context of increasing solar and battery storage. The Energy Bureau **ORDERS** PREPA to file the results of this study with the Energy Bureau, along with a proposed action plan for each facility informed by the study, within 180 days from the notification date of this Final Resolution and Order.

d. Existing thermal resources

869. As stated in Part III(G), all Scenarios retire the older steam units at Palo Seco, Aguirre, and San Juan during the timeframe 2019-2025, with most of those retirements occurring earlier, based on the model's incorporation of solar PV and battery storage, and peaking capacity, during the first five years of the planning horizon. All Scenarios generally retire the Costa Sur units 5 & 6 over the first few years of the horizon. All Scenarios retire the AES units at the end of 2027. The Aguirre combined cycle units are retired earlier in Scenario 1 and 3, and are retained for longer periods in Scenario 4, 5, and the ESM Scenario. The converted San Juan units 5 and 6 are generally retained until the 2030s, although both the ESM plan and Scenario 5 see an earlier economic retirement of unit 6, in 2025 or 2026. Generally, EcoEléctrica is retired only in Scenarios where a new F-class combined cycle is built at Costa Sur, or in the few Scenarios where a new CC is built at Mayagüez. Appendix C, Tables C-3, C-6 and C-7 show the retirement schedules.

870. The Energy Bureau **APPROVES** PREPA's plans for retirement of the oil-fired steam resources over the next five (5) years, at San Juan, including units 7, 8, 9 and 10; at Palo Seco, including units 3 and 4 and at Aguirre including steam units 1 and 2. PREPA will retire these units based on the installation schedule and location of any new peaking generation, new solar PV, and energy storage resources to address overall and local resource adequacy. The exact retirement sequence will be contingent on the amount and location of replacement resources procured by PREPA. However, the Energy Bureau **ORDERS** this to occur during the term of this Modified Action Plan and **WARNS** PREPA that undue delays in the retirement of these units will result in stringent penalties.

871. The Energy Bureau also **APPROVES** PREPA's plans for retirement of the Aguirre combined cycle units 1 and 2 over the next five (5) years. PREPA will retire these units based on the installation schedule and location of new peaking generation, new solar PV, and energy storage resources to address overall and local resource adequacy. The exact retirement sequence will be contingent on the amount and location of replacement resources procured by PREPA but shall occur during the term of this Modified Action Plan.

872. The Energy Bureau **ORDERS** PREPA to file with the Energy Bureau bi-annual status reports, commencing on April 1, 2021, that provide a near-term forecast (two years forward of the reporting date) of PREPA's expected capacity resource balance on a

seasonal basis and its ability to meet peak load and operating reserve requirements with existing and anticipated resources on its system at each of the forecasted intervals. PREPA shall include in these reports an explanation of how this expected capacity resource balance informs PREPA's plans to retire the oil-fired steam units or the Aguirre combined cycle units, or to convert certain steam units to synchronous condensing operation. Caveat Number 17 in PREPA's Proposed IRP[1354] indicates that retirement shall only be implemented after new resources are fully operational. PREPA must indicate in these reports the threshold capacity balance at which retirement for these units can commence, or continue, and provide an explanation of its rationale for decisions to retire, or retain, these units prior to or past the retirement dates listed in the resource development scenarios in the Proposed IRP.

873. The Energy Bureau **REJECTS** PREPA's plans for retirement of all eighteen (18) of the existing gas turbine peaking units located at Daguao, Yabucoa, Jobos, Vega Baja, Palo Seco, Aguirre, and Costa Sur and replacement with a new set of GTs. In Part III(D) of this Final Resolution and Order, the Energy Bureau **FINDS** that it may be reasonable to consider some limited thermal peaker replacement, but not a wholesale replacement of all units. The Energy Bureau **ORDERS** PREPA to establish a retirement schedule for the worst-performing of the 18 units and file this as part of the bi-annual status reports noted above for retirement of oil-fired steam and combined cycle units. The prioritization of the retirement schedule shall be based on availability and the need for a major overhaul as provided by PREPA in response to the Energy Bureau's Ninth ROI,[1355] or based on any other determining factor. The exact retirement schedule will be a function of the availability and location of competitively procured replacement resources described in more detail below.

874. The Energy Bureau **FINDS** that PREPA's plan to allow the repair and short-term operation of Costa Sur Unit 5 and 6 is reasonable. The Energy Bureau **EXPECTS** that both units will eventually retire within this Modified Action Plan period as solar PV and energy storage becomes available based on PREPA's retirement findings in the resource development scenarios summarized in this Final Resolution and Order, Appendix C, Tables C-3, C-6 and C-7. This would occur in conjunction with retirement considerations for oil-fired units noted above. The Energy Bureau **ORDERS** PREPA to further include in the bi-annual status report, the status of the operating condition of each Costa Sur unit and how such status factors in to PREPA's overall generation plant retirement plans.

875. The Energy Bureau **APPROVES** PREPA's plans for continued operation and year-end 2027 retirement of the AES units in line with the Act 17 prohibition of coal fired generation starting in 2028. The Energy Bureau is open to the evaluation of the

[1354] *See* Proposed IRP, page 9-4, Caveat Number 17.

[1355] PREPA response to Energy Bureau ROI-9-2, November 2, 2019.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

conversion of the AES units to natural gas as a possible alternative as part of the next IRP.

876. The Energy Bureau **ACCEPTS** PREPA's renegotiated EcoEléctrica PPOA and Naturgy Natural Gas Sale And Purchase Agreement. PREPA's additional modeling and response to Energy Bureau ROI-10-5 confirmed the overall economic value of inclusion of the renegotiated contract independent of the level of load or the Scenarios assessed.[1356]

877. The Energy Bureau **ACCEPTS** PREPA's conversion of the San Juan Units 5 and 6 to burn natural gas as a fixed decision (constraint) in the Proposed IRP. The New Fortress Energy contract expires in 2025. Accordingly, the Energy Bureau **ORDERS** PREPA to include the renewal and extension of the New Fortress Energy contract as an option, not as a constraint, in the next IRP.

878. In Part III(G) of this Final Resolution and Order, the Energy Bureau determined that it would be unreasonable to consider new LNG infrastructure at Yabucoa and Mayagüez. The conversion of the 200 MW Mayagüez peakers is linked to the new ship-based LNG infrastructure, so without the new LNG infrastructure there would not be a need to convert the units to natural gas combustion. No resource Scenario selected such conversion as an economic option. The inclusion of this conversion in the ESM Scenario is a fixed decision. As such, the Energy Bureau **DENIES** the conversion of these peakers to burn natural gas. However, the Energy Bureau **ORDERS** PREPA to retain the peakers. Since the units are a recent vintage (2009) generation resource,[1357] there is no expectation that their economic or age-related retirement might occur during the Modified Action Plan period.

e. New thermal resources

879. As discussed in Part III(G), the Energy Bureau **FINDS** that PREPA has not supported inclusion of a new combined cycle (CC) at Palo Seco by 2025 in a least cost plan. This discussion builds upon the findings and orders in that earlier Part of this Final Resolution and Order. Because the approval of a CC at Palo Seco was part of the Proposed Action Plan, with work beginning immediately, the Energy Bureau **DOES NOT APPROVE** this component of PREPA's Action Plan as proposed. Instead the Energy Bureau **APPROVES** the Modified Action Plan elements that follow.

880. PREPA demonstrated that under some circumstances a new fossil-fuel-fired plant at Palo Seco may be required,[1358] and that substantial preliminary analysis, study, permitting, and engineering work are required in order to develop a new fossil fuel

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[1356] PREPA response to Energy Bureau ROI-10-5, January 22, 2020 and January 29, 2020.

[1357] *See* Proposed IRP, page 4-1. Commercial operation date is 2009.

[1358] For example, in the case of S4S2B with base levels of energy efficiency and a full MiniGrid implementation.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

generation unit, especially if it requires a new LNG terminal and gas pipeline.[1359] PREPA stated that it considers beginning the permitting and engineering work for a "baseload, fast-responding" generator in the North (specifically at Palo Seco) to be a "least regrets" action.[1360] However, to protect against the uncertainty of near-future solar PV and battery energy storage price outcomes, or other potential reliability concerns, out of an abundance of caution and coupled with strict oversight as detailed in this Part, the Energy Bureau **FINDS** that PREPA may begin preliminary work on new generation and/or energy storage at Palo Seco, subject to the following process and constraints:

- As described earlier in the Modified Action Plan, this process **SHALL NOT** interfere or delay the procurement process for renewable and/or BESS resources.
- The approved preliminary work shall include a scoping and feasibility analysis, which shall:
    - take into account the response (in volume and pricing) to PREPA's solar and battery RFP(s), including evaluation of whether the results indicate that generation at Palo Seco may not be required;
    - include a process to gather information from vendors regarding indicative pricing for combined-cycle, reciprocating engine, and combustion turbine generators;
    - include a siting and permitting feasibility analysis for fueling infrastructure, including any necessary pipelines and terminals, for natural gas, LPG/propane, and diesel and other low-sulfur oil fuels;
    - account for any opportunity cost related to the siting of BESS resources or renewable energy resources at or near Palo Seco that would be incurred as a result of fossil fuel generation development at Palo Seco; and
    - include recommendations regarding the specific resources that may be needed at the Palo Seco site in order to most cost-effectively complement the resources being developed and deployed elsewhere in Puerto Rico.
- The objective of the scoping and feasibility analysis shall be to develop a revised and tailored proposal to the Energy Bureau for options regarding the Palo Seco site. When this study is complete, PREPA shall file it with the Energy Bureau along with a plan and requested resources to begin any necessary engineering and design work. The scoping and feasibility analysis shall include the data and findings from PREPA of the items listed above which includes but

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[1359] *See*, for example, Proposed IRP, pages 6-14 and pages 7-12.

[1360] Evidentiary Hearing, Testimony of Dr. Nelson Bacalao, February 7, 2020, morning session, 01:32:00 to 01:35:00.

are not limited to: renewable energy responses to the RFP as to volume and pricing; vendor pricing information for the thermal generation options; siting and permitting feasibility for fueling infrastructure; and, resource needs at the Palo Seco site. The Energy Bureau will evaluate and approve, modify, or reject PREPA's plan for how to proceed with necessary engineering and design at Palo Seco.

- PREPA shall optimize its utilization of the resources of prospective or selected vendors to conduct engineering and design work, as described by PREPA Executive Director Ortiz during the Evidentiary Hearing,[1361] in order to limit PREPA ratepayer cost.
- The Energy Bureau **DETERMINES** that PREPA may expend up to $5 million for preliminary economic, siting, permitting, and planning analysis regarding a new fossil fuel-powered unit at Palo Seco. This cost limit includes PREPA staff time as well as the cost of outside resources, analyses, and experts.

881. The Energy Bureau **WARNS** PREPA that it must be highly cost-efficient with any preliminary permitting and engineering activity it undertakes, and that these activities must not interfere with or delay the procurement of solar PV (or other renewable) and battery energy resources as directed in the Modified Action Plan and described elsewhere in this Final Resolution and Order.

882. The Energy Bureau **ORDERS** PREPA to submit quarterly reports, commencing no later than June 1, 2021 describing the work performed related to new generation at Palo Seco, the staffing or consultant resources used to complete the work, and the status of the overall preliminary efforts. If PREPA determines that additional funding in exceedance of the $5 million allocated is required, PREPA must explicitly request such funding and must provide substantiating data. In the event that PREPA requires funds in excess of $5 million in order to achieve the objectives identified herein, it shall request the Energy Bureau's approval prior to expending any additional funds. The Energy Bureau **ORDERS** PREPA to include in any filing requesting additional funds, the preliminary results of the work completed, clear scope and limits on the amount and use of additional funds, and data substantiating such request.

883. The fastest timeline described by PREPA in the Proposed IRP for new generation at Palo Seco would lead to commissioning in 2025, with engineering, procurement, and construction beginning no earlier than 2022. This date falls before the required date for PREPA to file its next IRP. In the event that, following the preliminary work described above, PREPA decides that it wishes to proceed to project development at Palo Seco before the filing of the next IRP, the Energy Bureau **WILL ALLOW** PREPA to make a substantive filing requesting approval. PREPA must make such a filing at a time that allows at least six (6) months between the filing and PREPA's target date to begin

[1361] Evidentiary Hearing, February 7, 2020, morning session, 00:17:50 to 00:19:05.

project development. This filing must include PREPA's best current information regarding the need, cost, and performance of new generation and/or storage at Palo Seco, along with associated fueling infrastructure, including economic and environmental analysis demonstrating the need for and role of the proposed facility in a least-cost portfolio consistent with Puerto Rico public policy.

884. As addressed in Part III(G), PREPA has not supported its claim that additional gas infrastructure at Mayagüez and Yabucoa as contained in the ESM Scenario as a "fixed decision" is needed. The Energy Bureau therefore **ORDERS** PREPA not to expend resources on the siting, permitting, procurement, engineering, design, or other preliminary work for LNG infrastructure or new fossil-fuel powered generation facilities at Yabucoa or Mayagüez. The Energy Bureau agrees that locating power supplies closer to load increases reliability and resilience, and support locating renewable generation and battery storage in the East and West (in the areas of Yabucoa or Mayagüez) using competitive processes, as discussed above.

885. As addressed in Part III(G), PREPA has not supported inclusion of approximately 400 MW of exclusively new fossil-fuel peaking resources in a least cost plan. This generation capacity proposal was not open to all generation technologies and was selected mainly to support the MiniGrid construct which increases the reserve requirement for thermal resources. However, the Energy Bureau **FINDS** that replacement of a portion of PREPA's older gas turbine resources with peaking resources is consistent with this Modified Action Plan, subject to the following process and constraints:

- Unless otherwise approved by the Energy Bureau and consistent with the Optimization Proceeding discussed below, PREPA shall replace no more than 147 MW of gas turbine capacity with fossil-fuel generators providing peaker services, if after a competitive bidding process open to all single or aggregated sources of demand and supply-side options, these services can be procured competitively at lower cost than other options. (147 MW is the sum of the capacity of the seven Frame 5 units identified as in need of a major overhaul or major generator repair in PREPA's response to the Energy Bureau's ROI 9-2, Attachment 1.) When determining the total required capacity of new peaking generation to replace the retired Frame 5 units, PREPA shall include in its analysis the peaking capacity provided by the MegaGen mobile units totaling 66 MW installed at Palo Seco. This leaves up to 81 MW of new capacity to procure.
- In order to provide geographic distribution for peaking resources and increase resilience to forced outages, PREPA shall consider placing peaking resources at existing locations that would have zero or only one remaining peaking generator after Frame 5 retirements: Costa Sur, Aguirre, and Yabucoa.
- PREPA shall select the supplier or suppliers for replacement generators through competitive procurement processes intended to solicit competitive

bids from multiple vendors, and consistent with the processes laid out in Regulation 8815.

- In its competitive procurement process, PREPA shall design the procurement to solicit providers of services to the energy grid, rather than specific technologies. That is, PREPA shall define the services to be provided (such as peak capacity or reduction, fast ramping, black start, or load following services) rather than the specific technologies (GTs, RICE units, DR programs, renewables with batteries, etc.). PREPA may require, subject to the Energy Bureau approval, that proposed projects meet a minimum performance threshold or service during and after major storms.
- Any RFPs issued for such replacement peaking resources will be separate from RFPs for renewable and battery energy storage resources noted above and must be approved by the Energy Bureau.

5. Demand-Side Resources

a. Energy efficiency

886. As demonstrated in Parts III(B) and III(G) above and stated in the Proposed IRP,[1362] EE is a lower cost resource than any supply-side resource evaluated in the IRP. Several parties to this proceeding have identified EE as part of a "no regrets" set of actions to advance Puerto Rico's energy objectives, or otherwise stated support for extensive investment in cost-effective EE.

887. PREPA's Proposed Action Plan includes only a general call to establish EE programs and pursue savings of 2% per year. The Energy Bureau **FINDS** that the Action Plan for the IRP must contain greater detail and specificity than that provided by PREPA. As part of the Energy Bureau's mandate to pursue least cost energy systems for Puerto Rico, and in support of the objective of thirty percent (30%) EE savings by 2040 enshrined in Act 17-2019, the Energy Bureau therefore **REJECTS** PREPA's Action Plan regarding EE. The Energy Bureau **ORDERS** that this Modified Action Plan include the items discussed below.

888. The Energy Bureau's objective for EE programs is to capture all available cost-effective EE. The evidence in the Proposed IRP proceeding shows that at least 2% per year energy savings are cost effective. The scenarios modeled which met this objective showed lower present value of revenue requirements from PREPA ratepayers by more than $1.5 billion when compared with scenarios without EE (and more than $1 billion relative to Low-EE cases), even after accounting for the exclusive ratepayer funding of EE programs. Consistent with Regulation 9021, the Energy Bureau established a goal of 2% per year EE savings, to be achieved as soon as practically possible, and subject to

[1362] *See* Proposed IRP, page 10-22.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

change as potential studies and other new information apprise the Energy Bureau as to the true extent of achievable cost-effective EE.

889. The Energy Bureau understands from evidence presented in this proceeding that EE programs cannot be successfully launched at their full potential scale immediately. However, the evidence also shows that "quick start" EE programs may be able to be rapidly launched and deliver savings while developing and ramping up comprehensive programs that meet the objective of all available cost-effective efficiency. A ramp up gives time for programs to mature, for program staff and relevant workforces to develop expertise, and for electric customers to increase their appreciation of EE when making energy consumption choices. The Energy Bureau has convened a series of workshops regarding EE program design and implementation which will inform our subsequent regulations and other actions. We encourage stakeholders to continue to be involved. The next step is the completion of the EE Regulation rulemaking procedure.

890. The Energy Bureau **ORDERS** PREPA to organize and coordinate the necessary resources to timely comply with, and facilitate the successful implementation of, the EE Regulation.

891. PREPA **SHALL TAKE ALL NECESSARY STEPS** to support the Energy Bureau's actions to acquire cost-effective energy efficiency as part of a least-cost electric system, including support for program implementation, analysis, funding, and financing.

b. Demand response

892. While PREPA's Action Plan for DR calls for acquiring 60 MW of DR resource by 2025,[1363] and the Energy Bureau has accepted that value for the purposes of modeling in the Proposed IRP, the evidence in this proceeding (as described in Part III(B)) also indicates that PREPA's commercial and industrial customers may be able to offer some emergency DR in the form of self-supply generation. In a separate proceeding (Case No. NEPR-AP-2020-0001) the Energy Bureau has ordered PREPA to pursue up to 250 MW of DR from these customers as part of the process to maintain reliable service in the aftermath of earthquake damage to Costa Sur.[1364] Customers with battery energy storage may also be able to provide DR services in an aggregated fashion, such as through VPPs (see below). Meanwhile, the Energy Bureau is required by Act 17 to develop and issue guidelines for DR. Taking into consideration this evidence and context, the Energy Bureau **MODIFIES** the Action Plan regarding DR as discussed below.

[1363] *See* Proposed IRP, page 10-22.

[1364] Resolution and Order, In Re: Request for Proposal for Temporary Emergency Generation, Case No. NEPR-AP-2020-0001, May 22, 2020, page 14.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

893. Similar to EE, DR resources can provide flexibility for grid operations at lower cost than supply-side resources. Such DR resources must be controllable by the system operator. In addition, DR resources may consist of aggregations of flexible customer loads. Control may take the form of direct dispatch (in which a signal is sent directly to a set of loads at a specific time to achieve a specific result), or through more indirect methods such as time-varying price signals to change customer behavior so that usage more clearly aligns with system costs. The Energy Bureau has issued an informal preliminary draft of DR regulations for stakeholder comments,[1365] and intends to commence the formal rulemaking process to adopt DR regulations in the coming months.

894. Consistent with the Modified Action Plan components regarding distributed storage and VPPs, PREPA **SHALL DEVELOP** internal systems as well as external programs, offerings, and/or solicitations to engage aggregators of DR resources to offer, dispatch, and be compensated for cost-effective DR resources. This shall be available to all customer classes.

6. Transmission and Distribution

a. Framework for resilience

895. In Part III(I), the Energy Bureau found that the comprehensive whole of PREPA's MiniGrid construct did not provide an optimal solution to PREPA customer needs. The Energy Bureau found that PREPA failed to properly consider an optimized transmission plan and ordered PREPA to develop an implementation strategy to optimize transmission spending.

896. The Energy Bureau **ACCEPTS** the MiniGrid concept as a mechanism to provide resiliency during the loss of transmission or distribution system operations due to severe weather events. Nevertheless, the Energy Bureau **DOES NOT APPROVE** the MiniGrid design/construct as proposed by PREPA due to its lack of optimization. The Energy Bureau found that microgrids, single-site solar PV and battery storage, and aggregated solar PV and battery storage or VPPs were a critical part of an overall solution to ensure resiliency. In Part III(G), the Energy Bureau accepted PREPA's acknowledgment that VPPs can provide energy and capacity services and directed PREPA to include aggregations such as VPPs as eligible to compete with utility-scale renewable and battery storage resource deployment and to provide DR services.

897. The Proposed IRP includes as a first recommendation the central role that customer participation should play in the provision of DR and customer-side energy resource provision. PREPA also notes that the distributed nature of new resources will support economic growth and cites the importance of "zones of resiliency" to enable recovery

[1365] Resolution, In Re: Regulation for Energy Efficiency and Demand Response, Case No. NEPR-MI-2019-0015, July 2, 2020.

from weather events. Intervenors cited the importance and ability for distributed resources to play a role in providing resiliency. For example, as noted above, Mr. Sandoval emphasized the importance of engaging stakeholders directly when examining the conditions being mitigated by resiliency solutions.

898. Based on the discussion and findings from Parts III(D), III(G) and III(I), and the DG and microgrid promotion policies embedded in Act 17, the Energy Bureau **FINDS** that part of the Modified Action Plan will be the establishment of a framework for resilient system operation at reasonable cost that includes the following elements:

- Preservation of the option to better optimize T&D system expenditures for resiliency, including aspects of PREPA's MiniGrid concept. This element includes expenditures for general hardening of the T&D system, as described in Part III(I). A separate proceeding, further described below, will be commenced by the Energy Bureau to optimize the MiniGrid concept. In that proceeding, the Energy Bureau will initially explore how the combination of distributed resilience and a MiniGrid-like approach in one or two adjacent MiniGrid regions can best be optimized to obtain resilience at the lowest reasonable cost taking into consideration the economic effects that extended outages can cause.
- Review and elaboration on the definition and identification of different classes of customers regarding the criticality of electricity service, and associated expected levels of resiliency.
- Emphasis on the central role that customers can play through provision of energy supply and DR. This element will allow for customers with battery storage resources, self-supplied energy, or other means of DR to provide capacity to PREPA during periods when weather events threaten the reliability of the electric power system, after such events, or during "blue sky" periods when the peak demands on PREPA's system strain available supplies.
- Provision of microgrid and related single-site (individually, or in the aggregate as VPPs) local capacity and energy solutions for both, resiliency provision and contribution to energy and capacity needs during normal periods, in accordance with Act 17 promotion of microgrids and distributed energy resources.

899. The Energy Bureau will open a MiniGrid Optimization proceeding (Optimization Proceeding) following the issuance of this Final Resolution and Order. The Energy Bureau **FIND**S that this proceeding will be the forum to further explore the costs, benefits, and alternative configurations of combinations of wires (i.e., hardened T&D assets) and local distributed resources that best serve Puerto Ricans in safeguarding against the effects of short-term and extended electric system outages that can occur as a result of severe weather events. This will be the proceeding where PREPA complies with the Energy Bureau's Order from Part III(I) to provide an analysis of the lowest

reasonable cost options when considering deployment of small-scale, distributed resources as complements to transmission hardening such as proposed in the MiniGrid transmission investments.

900. The Energy Bureau **EXPECTS** that this proceeding will commence in the Fall of 2020.

901. The Energy Bureau currently envisions the proceeding as a variation on the technical conference formats used in past explorations. The Energy Bureau is particularly interested in obtaining community and stakeholder input into the nature, number, critical and priority loading requirements, and identification of specific essential facilities that should be prioritized for targeted efforts to ensure operation following a severe weather event, as well as information regarding the investments that such facilities may have already made in distributed resilience solutions. The Energy Bureau is also interested in obtaining input on how to best balance a need for local resource provision, with a need to prevent unwarranted and costly overbuilding of energy or capacity resources for resiliency purposes.

902. The Energy Bureau **ESTABLISHES** the San Juan/Bayamon region as the first MiniGrid region to be considered for optimization due to the relative density of load in that region. Notwithstanding the foregoing, the Energy Bureau is open to stakeholder or PREPA suggestions as to whether a different MiniGrid region or other zone might be better examined initially. The Energy Bureau assures residents of other regions that we intend to develop approaches that can promptly be applied beyond the first region or regions to be examined in order to achieve appropriate equity across Puerto Rico.

b. Transmission

903. In Part III(I) the Energy Bureau accepted PREPA's plans to spend up to $2 billion in total over the next decade, for transmission hardening of existing elements and aging infrastructure.

904. The Energy Bureau **ACCEPTS** as part of the Modified Action Plan the portion of PREPA's proposed Action Plan that included prioritized expenditures to bring existing transmission system assets up to current or new Standards, as seen in the Proposed IRP Exhibit 10-11, and totaling $1.15 billion through 2025.

905. The Energy Bureau **DISAPPROVES** at this time the $5.9 billion in MiniGrid expenditures, as proposed by PREPA. In the Optimization Proceeding noted above, the Energy Bureau will consider transmission needs associated with an optimized MiniGrid transmission system and establish the appropriate MiniGrid and related transmission expenditures.

c. Distribution

906. PREPA must ensure that the improvements required for distribution system resiliency align with and reflect a prioritization for the type of investment that supports increasing the ability for DG to be connected to the distribution system. As PREPA considers the voltage consolidation it discusses in the Proposed IRP, noted in Part III(I) of this Final Resolution and Order, it should ensure that all voltage upgrades and voltage control additions to the distribution system explicitly focus on maximizing the ability of the system to support more DG, as the Energy Bureau ordered in that Part. As PREPA considers distribution resiliency investments, it must conduct and report upon the specific analyses required – those that were described as "beyond the scope of this [IRP] evaluation"[1366] – to further progress towards allowing all of its system to incorporate DG.

907. The Energy Bureau conditionally accepted PREPA's plans for $911 million in distribution system investments for resiliency and support for DG in Part III(I) of this Final Resolution and Order. The Energy Bureau ordered PREPA to coordinate all distribution system spending with its ongoing efforts in integrated distribution system planning and maximizing the ability of the distribution grid to integrate DG, especially solar PV and batteries required throughout Puerto Rico as part of the modified Preferred Resource Plan, set out in this Modified Action Plan. The Energy Bureau noted in Part III(I) that this distribution system investment is conditioned upon upgrade requirements that remain even under resiliency approaches that do not involve deployment of the full MiniGrid approach.

908. As noted in Part III(II), the Energy Bureau expects PREPA to directly consider how distribution system investments for resiliency may be modified to reflect an optimized approach to MiniGrid transmission investment and the Energy Bureau ordered PREPA to directly consider distribution system planning impacts when participating in the Optimization Proceeding noted above.

909. The Energy Bureau further determined that until an Integrated Distribution System Plan is developed, PREPA shall proceed on a parallel path of maximizing the ability of the distribution grid to incorporate all forms of DG.

910. The Energy Bureau **ORDERS** that the Modified Action Plan include distribution system investment and analysis including integration of DG in accordance with the discussion above and the related findings in Part III(I).

[1366] *See* Proposed IRP, page 10-19.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

7. Modified Action Plan – Table of Components[1367]

Element	Determination	Modification	Description/Comment
MiniGrids (MG) and other Transmission	**Modified**	Optimization Proceeding– new process to focus on one or two adjacent MiniGrid regions and optimize transmission needs. Account for distributed resilience provision/use of microgrids within MG regions when optimizing transmission needs.	$2 Billion for other non-MiniGrid transmission elements. All related expenditures /investments shall be approved by the Energy Bureau. Expenditures of $5.9 billion initially for investment in optimal approaches including distributed resilience, microgrid and VPPs, and selective MiniGrid investment if determined to be optimal.
Distribution Hardening	**Accepted with conditions**	Entire distribution system. Through 2026.	Must coordinate DG installation needs with this approach – voltage control, reconductoring, possible reconfiguration (*i.e.*, feeder switching). Must coordinate with ongoing Energy Bureau's Integrated Distribution System Planning. Must include hosting capacity assessments. Feeder mainline undergrounding and substation upgrades to GIS. All related expenditures /investments shall be approved by the Energy Bureau.
Solar PV	**Modified**	Least cost is maximum procurement. Inclusive of renewable DG and renegotiated PPOAs, at least 3,500 MW new solar by 2025 (S3S2B Full EE), up to 3,900 by 2025 (S3S2B Low EE). Appendix C, Table C-5.	RFP structure to procure contracts for installation to reach at least S3S2B Full EE targets. Scenario-dependent. Customer-owned renewable DG installations and re-negotiated renewable PPOAs count towards

[1367] It it important to note that this table is a summary and as such, it shall not be construed in any way as superseding other related determinations (*e.g.*, findings and/or orders) made by the Energy Bureau in other parts of this Final Resolution and Order.

Element	Determination	Modification	Description/Comment
			overall targets, to meet RPS requirements.
Battery Energy Storage	**Modified**	At least 1,360 MW of battery storage, by 2025, S3S2B "Full EE"; up to 1,480 MW S3S2B, "Low EE" by 2025.	RFP structure to procure contracts for battery installation to reach at least S3S2B "Full EE" targets, and possibly higher levels if economic and available. Explicitlly allows VPP, distributed batteries.
New Gas Turbines	**Rejected**	N/A	Was a fixed decision, for eighteen, 23 MW new GTs with containerized NG fuel. Not least cost. RFPs for local capacity need for up to 81 MW to be technology agnostic.
Accelerate Energy Efficiency and Demand Response	**Modified**	Support all necessary steps to establish EE programs at 2%/year savings including quick-start programs. Implement DR Guidelines when issued; seek DR capacity from C&I customers and aggregators initially, followed by residential.	The savings are least cost resources.
Enable Demand Response and Increased Distributed Generation	**Accepted with Emphasis**	PREPA to support all DR offerings including VPP and new C&I DR offerings. PREPA to coordinate all distribution system reinforcement and spending to enable integration of maximum levels of distributed generation.	PREPA must develop systems to enable greater levels of demand response than those modeled in the Proposed IRP. PREPA distribution system planning and expenditures must maximize the ability of the distribution system to support distribution system DG.
Convert Retired Plants to Synchronous Condensers	**Accepted**	N/A	8 units across San Juan, Palo Seco, Aguirre locations, over full planning horizon, for eventual conversion to synchronous condensers as necessary. Retire and use SJ 9&10 first for synchronous condensing. Six months to convert 1 unit.

NEGOCIADO DE ENERGÍA
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO
DE PUERTO RICO

Element	Determination	Modification	Description/Comment
Unit Retirements	**Accepted with conditions**	A portion of Frame 5 peakers, Aguirre Steam 1 & 2, San Juan Steam 7 & 8, Palo Seco Steam 3 & 4, Aguirre CC 1 & 2, Costa Sur 5 & 6. No undue delays in retirement, all MATS-impacted unit retirements expected during term of Modified Action Plan.	In first five years of plan, subject to availability of new generation resources. Conditions: metrics to indicate capacity headroom. Bi-annual status reporting on retirement plan.
Convert San Juan 5 & 6 to Gas	**Accepted**	N/A	Completed.
New CCGT at Palo Seco	**Does Not Approve the development of new unit, as part of least cost plan.**	Preliminary work approved for limited siting, permitting and feasibility analysis, up to $5 million.	Preliminary economic, siting, permitting, and planning analysis allowed with strict guidance. **Activity must not interfere with or delay renewable energy and battery procurement processes**. Energy Bureau required periodic reporting on preliminary work authorized.
Develop Land-Based LNG terminal in San Juan for new CCGT and SJ 5&6	**Does Not Approve, as part of least cost plan.**	N/A	Need is dependent on Palo Seco CCGT being implemented..
EcoEléctrica contract renegotiation and extension or new CCGT at Costa Sur	**Accepted – contract extension**	EcoEléctrica contract extension through 2032. Maximum capacity increases to 530 MW from 507 MW. No new CCGT at Costa Sur.	Reduced capacity payments; increased fuel costs.
Preliminary Activities for Ship-based LNG at Mayagüez for existing 4 x 50 MW gas turbines and possible new CCGT	**Rejected**	N/A	Fixed Decision in ESM Plan. Not least cost.
Preliminary Activities for Ship-based LNG at Yabucoa for new CCGT	**Rejected**	N/A	Fixed Decision in ESM Plan. Not least cost.
Contract cessation/retirement of AES by end of 2027	**Accepted**	N/A	Energy Bureau will consider conversion to natural gas during next IRP.

V. PREPARING FOR THE NEXT IRP CYCLE

911. The next IRP proceeding must take less time, produce more value, and result in an IRP that the Energy Bureau can approve without significant modifications. Although since the 2016 IRP, PREPA has shown some progress, PREPA must still continue to improve its resource planning process so that future IRPs comply with the public policy and Regulation 9021, while matching or exceeding industry standards. This Part summarizes specific action items and internal process improvements for the next IRP.

A. Specific Action Items

912. In Parts III and IV of this Resolution and Order, the Energy Bureau has documented specific action items to be incorporated in the next IRP. The Energy Bureau **ORDERS** PREPA to incorporate in the next IRP the specific action items listed below by category.

1. Energy Efficiency and Demand Response

913. Regarding Energy Efficiency and Demand Response, as part of its preparation for the next IRP, PREPA shall:

- Incorporate the results of the Energy Efficiency market baseline and potential studies as part of its projections of energy efficiency;
- Compare the costs and performance of the Energy Efficiency programs modeled in the IRP with similar and best-practice programs in other jurisdictions;
- Demonstrate that the Energy Efficiency programs modeled in the IRP are cost-effective;
- Incorporate a Demand Response resource projection that shall reflect the Energy Bureau's forthcoming Demand Response Regulations. This should result in a decrease in peak demand that may be modeled in the load forecast and/or as a supply resource; and
- Account for the potential of interruptible load tariffs for large commercial and industrial customers.

2. Distributed Generation and Storage

914. Regarding Distributed Generation and Storage, as part of its preparation for the next IRP, PREPA shall:

- Incorporate the impacts of shaping distributed resilience solutions that use Distributed Generation (as discussed in Part III.(I) and Part IV of this Final Resolution and Order) by utility action or programs that could change the Distributed Generation deployment trajectory;

- Test the market and determine up-to-date solar PV prices for development in Puerto Rico. It should use these processes both to acquire solar PV, and to develop prices for use in its next IRP analyses. PREPA shall no longer rely on a uniform 16% cost adder factor for solar PV, batteries, or any renewable resources for planning purposes, and instead base its analysis on the results of actual solicitations and market-available prices for development and installation in Puerto Rico;
- Incorporate distributed storage resources that can provide Demand Response services as a modeled resource. This may result in the resource being treated as a Demand Response resource and/or as part of a virtual power plant as a supply resource;
- Include in its Distributed Generation and Storage adoption rates considerations that include, but not be limited to, PREPA rates, programs, Puerto Rico policy considerations, and reflects grid defection; and
- Use the results of its efforts to acquire distributed storage resources to provide grid services to inform its assumptions regarding the cost, availability, and performance of distributed storage.

3. Load Forecasting

915. Regarding Load Forecasting, PREPA shall:

- Consider the improvements to its load forecast that include, but are not limited to, impacts of commercial load forecast and the use of independent variables including, but not limited to, GNP, population, and weather;
- Incorporate the impact and a range of adoption scenarios of Electric Vehicles. These EV forecasts must include a range of potential EV adoption rates that are consistent with Puerto Rico's stated public policy, be informed by Puerto Rico and mainland U.S. automobile markets, and account for the impact of controlled and uncontrolled EV charging on peak demand; and
- Account for federal appliance standards, building codes, and relevant governmental programs, such as weatherization assistance or Puerto Rico programs to improve Energy Efficiency in government facilities, in the development of its load forecast and Energy Efficiency projections.

4. Wind Resources

- Conduct an offshore wind study tailored to Puerto Rico's wind resource and electric grid that evaluates the cost, generation profile, and other characteristics of anchored and floating wind turbine options;
- Properly and fully account for market-based costs and evening peak performance of onshore wind resources, and especially considering the

performance of onshore wind resources designed for "low wind" regimes, using the most up-to-date information available; and

- Properly and fully account for market-based costs and evening peak performance of offshore wind resources, using the most up-to-date information available.

5. Resource Need Assessment

916. With respect to Resource Need Assessment PREPA shall include in the body of its IRP:

- A load and capacity resource balance by year for all years of the planning period based on the then-existing system, including all resources that are contracted to be deployed at the time of the IRP; and
- A forecast of "annual net position" by year for all years of the planning period based on the then-existing system, including all resources that are contracted to be deployed at the time of the IRP and based on use of a threshold planning reserve margin.

6. Caveats and Limitations

917. With respect to Caveats and Limitations, if PREPA chooses to use a scorecard, it shall include specific quantitative weightings for any attribute, with accompanying explanation and rationale for any assigned weights.

7. Transmission and Distribution

918. Regarding Transmission and Distribution, PREPA shall:

- Incorporate how resource plans could affect requirements for T&D spending;
- Consider how to optimize the development of a resource plan or implementation strategy with considerations for transmission spending; and
- Incorporate the results of any and all ongoing integrated distribution system planning, and hosting capacity analyses.

8. Modified Action Plan

919. With respect to the Modified Action Plan, PREPA may consider as a possible alternative, the conversion of the AES coal plant to natural gas fueled operation as part of the next IRP.

B. Internal Process Improvements

920. In terms of PREPA's internal process, the Energy Bureau **ORDERS** PREPA to incorporate in the next IRP by category include the items listed below.

1. Processes for Improving the IRP Filing

921. There are a number of areas in which PREPA would benefit from improving its internal organization and process, which in turn will result in an improvement to the quality of its IRP filing and the timeliness of information submittals. The Energy Bureau **ORDERS** PREPA to submit, no later than a year from the notification date of this Final Resolution and Order, a detailed report describing how PREPA will improve its resource planning process. The foregoing report shall include, at a minimum, the following:

- The specific steps that PREPA intends to take to address all deficiencies in PREPA's Proposed IRP and the Proposed Action Plan identified in this Final Resolution and Order;
- The names and positions of PREPA executives and managers responsible for taking those steps;
- The dates by which those steps will be taken, shown in a Gant Chart that identifies any steps critical for the timely completion of the process (i.e., steps that are prerequisites to subsequent ones);
- A description of the modeling framework that PREPA will use in the next IRP;
- A description of which internal departments, divisions, areas, or components (collectively, departments) will have responsibilities in the development of the next IRP, which shall include a description of those responsibilities, and the names of each of the departments' leaders;
- A description of the professional development efforts PREPA that will undertake to ensure that its personnel are sufficiently educated and experienced on the applicable public policy requirement including, but not limited to, the requirements of Act 17, Act 57, Regulation 9021, and standard industry practices regarding long-term resource planning; and
- A description of how PREPA will improve its record-keeping practices, including how it will (i) save, in digital form, vital communications, memoranda, white papers and contracts, and (ii) ensure clear lines of control and authorship for all data and analyses.

2. Selection of the IRP Technical Consultant:

922. This proceeding demonstrated the impact of having to fully rely on the services of an outside technical consultant on the timeliness and efficiency with which those submissions are prepared and filed. Additionally, the standardized selection of a

qualified technical consultant is important given that the cost of such engagement is borne by the ratepayers. Therefore, the Energy Bureau **ORDERS** PREPA's selection of technical consultant for IRP-related services to comply with the following requirements:

a. No later than one (1) year from the notification date of this Final Resolution and Order, PREPA shall submit for the Energy Bureau's review and approval a draft Request for Qualification ("RFQ") for IRP consulting services. Such draft RFQ shall set forth the minimum qualification requirements for providing IRP-related consulting services;

b. The Energy Bureau may require PREPA to submit a modified draft RFQ, as necessary and shall issue a determination, among other things, (i) approving the final draft of the RFQ; and (ii) providing guidance and direction to PREPA as to when it must issue the RFQ;

c. PREPA shall receive the responses from interested consultants and qualify the respondents based on the requirements contained in the approved RFQ;

d. PREPA shall submit to the Energy Bureau a pool of potential consultants, accompanied by a certification from a responsible PREPA executive that each member of the pool satisfies the requirements of the RFQ. PREPA shall also provide to the Energy Bureau copies of any documents relied upon by PREPA in determining such certification;

e. Upon a determination by the Energy Bureau that the members of the pool satisfy the RFQ requirements, PREPA shall submit to the Energy Bureau, for its review and approval, a draft contract for the rendering of IRP-related consulting, which shall include a detailed scope of the services covered by the contract;

f. Upon the Energy Bureau's approval of the draft contract, PREPA shall require proposals from the qualified consultants and commence negotiations with the qualified consultants;

g. While PREPA will have discretion to choose one or more consultants from the proposals received, PREPA is required file a report with the Energy Bureau regarding the negotiation process. PREPA shall demonstrate to the Energy Bureau's satisfaction the rationale of the selection process. Such report shall contain, for the Energy Bureau's approval, a final draft of the proposed contract and a detailed description of any deviations on the terms and conditions of the contract from the draft previously approved by the Energy Bureau and a redline version highlighting such deviations; and

h. PREPA shall execute the contract with the chosen technical consultant, after obtaining approval from the Energy Bureau.

NEGOCIADO DE ENERGÍA NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO DE PUERTO RICO

VI. Findings of Fact and Conclusions of Law

A. Findings of Fact

923. In developing its resource plan, PREPA used the Aurora LTCE model to evaluate the costs of each considered case. The Aurora model seeks to minimize the present value of revenue requirements for PREPA within the constraints set for each case, while maintaining reliable levels of electric supply to meet load throughout the study period. PREPA modeled through the end of 2038, representing a 20-year span from the beginning of 2019. PREPA conducted further "nodal" analysis to evaluate how the configuration and capabilities of PREPA's transmission system impact congestion, technical losses, production costs, renewable curtailment, and energy not served.

924. The evidence demonstrates that the IRP analysis was conducted in the context of declining load. Even before incorporating the impacts of EE and DG, projections of Puerto Rico's falling population and slow economic growth lead to projections of declining load. Further, the impacts of Hurricanes Irma and María have led PREPA to propose a fundamental change in the geographic configuration of its generation fleet, with generation moving closer to load. This shift led PREPA to include substantial changes in T&D in its IRP, rather than being solely or primarily concerned with generation. The evidence demonstrates that changes in public policy regarding renewable electricity supply and EE have been reflected in this Proposed IRP.

925. The evidence demonstrates that PREPA has met the requirements of presenting a forecast of future capacity and energy demand requirements, as well as an analysis of prior load forecasts in accordance with Section 2.03(C) of Regulation 9021. However, while the net effects are relatively small, the evidence shows that PREPA did not properly identify the variables used in the commercial sector load forecast.

926. The evidence demonstrates that PREPA did not include Electric Vehicle loads explicitly in its forecast and that this load should be included in future forecasts. The evidence demonstrates that PREPA's Proposed IRP contained analysis of thirty-five (35) resource plans, or 35 separate Scenarios, and the results were summarized in Exhibits 8-1, 8-2, and 8-3. An additional fifty-two (52) sets of modeling results are also presented by PREPA, Forty-six (46) and six (6) of which are in response to the Energy Bureau and AES-PR's ROIs respectively, giving rise to a total of eighty-seven (87) resource Scenario results presented in the Proposed IRP.

927. Based on the evidence, PREPA has met the requirements of Section 2.03(F)(3) with respect to identifying a wide range of potential new EE and DR programs. These programs will be assessed in more detail once the EE program is implemented.

928. The Energy Bureau accepts the evidence on the quantity and cost-effectiveness of DR that PREPA has presented, for the purposes of this IRP.

929. The evidence demonstrates that PREPA correctly determined that EE is always the least cost resource and lowers demand at far less cost than new supply and associated T&D.

930. The evidence supports a maximum level of EE deployment as a core provision of an approved Preferred Resource Plan.

931. The evidence demonstrates that PREPA has complied with the requirements in Section 2.03(D)(1)(a) and(B) of Regulation 9021 by providing summary tables of existing resources and supplemental information on PREPA's supply-side resources.

932. The evidence demonstrates that PREPA has failed to comply with Section 2.03(D)(1)(c) of Regulation 9021 in that PREPA did not provide annual anticipated non-environmental capital expenditures for the next 10 years. The evidence also shows that PREPA did not provide the expected capital and operating costs for compliance with current, proposed, and reasonably anticipated regulatory and legal requirements. Finally, PREPA has not summarized supplemental information on important changes to resources that have occurred since the approval of the most recent IRP.

933. The evidence demonstrates that PREPA failed to comply with Sections 2.03 (E)(1) and (2) of Regulation 9021 in that PREPA did not directly provide an annual load and resource balance table for existing conditions, nor did it provide an "annual net position" under any set of resource or load combinations.

934. The evidence demonstrates that PREPA's resource need analysis has not sufficiently conveyed fundamental information concerning the amount of capacity that PREPA may need over the planning horizon.

935. The Energy Bureau finds that based on the evidence, the use of the uniform 16% cost adder is acceptable for the planning purposes of this Proposed IRP only and that in the future PREPA should base its analysis on the results of actual solicitations and market-available prices for development and installation in Puerto Rico.

936. The Energy Bureau agrees with PREPA that the evidence supports the specific "no regrets" elements, of i) renewable energy and storage, ii) maximization of EE provision, iii) integration of DG, and iv) hardening of aspects of the T&D system, as forming the core of a Modified Preferred Resource Plan for PREPA.

937. The Energy Bureau finds that evidence that supports the conversion of retired steam generating plants to synchronous condensers in support of voltage requirements that reflect increasing levels of inverter-based generation (from solar PV and battery energy storage) is reasonable.

938. The evidence does not support PREPA's exclusion of S3S2 from consideration as a Preferred Resource Plan inasmuch as PREPA based the exclusion on unfounded cost assumptions, and its technically inappropriate exclusion of the load of battery storage during peak solar output times, when comparing and reporting solar PV to forecasted peak load ratios across alternative Scenarios.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

939. The evidence supports planned procurement action to resolve the uncertainties regarding the actual cost for solar PV and battery storage.

940. The evidence demonstrates that from a climate change mitigation perspective, Scenario S3S2B is preferable to the ESM and the S4S2B Scenarios.

941. The evidence supports the retirement of PREPA's older, oil-fired steam assets in order of the declining cost to operate when they are no longer necessary for system reliability and in alignment with synchronous condenser conversion.

942. The evidence supports the retirement of Costa Sur 5 & 6 when reliable system operation can be supported without their presence, after retirement of the oil-fired resources.

943. The evidence does not support PREPA's claim that additional gas infrastructure at Mayagüez and Yabucoa, as contained in the ESM Scenario as a "fixed decision," is needed. The evidence also demonstrates that it is not reasonable to plan for backup gas delivery locations when even PREPA's primary preferred location for a new gas combined cycle unit, at Palo Seco, has not been shown to be a robust choice for a preferred resource plan.

944. The evidence demonstrates that PREPA chose the ESM Scenario as its Preferred Resource Plan. The Energy Bureau has rejected this plan as the Preferred Resource Plan because PREPA did not rely on NPVRR as the primary criterion in choosing the ESM as required by Section 2.03(H)(2)(d)(i) of Regulation 9021. Consequently, the evidence shows that PREPA was unable to demonstrate the economic benefits of the ESM as compared to competing plans that PREPA included in the IRP. However, the Energy Bureau retained five core elements of PREPA's ESM Scenario as part of a Modified Preferred Resource Plan and Modified Action Plan, because they contain elements common to all plans, are "no regrets" actions and are reasonable. These actions are: timely conversion of older steam plant infrastructure to synchronous condensers to provide dynamic reactive support, and stability and inertial characteristics for PREPA's system after installation of increased quantities of solar PV; EE deployment, to the maximum amount obtainable as seen in "full EE" Scenarios; maximum procurement of solar PV in line with all Scenarios; battery energy storage as an element of a Modified Preferred Resource Plan; and, hardening of T&D.

945. The evidence demonstrates the reasonableness of PREPA's modeling results that include substantial needs for new solar PV and battery resources in the near and longer-term for Puerto Rico and fully supports competitive procurement of these resources from among both utility-scale, and smaller, distributed scale VPPs, as long as technical specifications are met.

946. The development of 400 MW of new fossil-fuel peaking resources in the Proposed IRP is not supported by an evidentiary demonstration of need.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

947. PREPA has demonstrated the reasonableness of replacing a small portion of older GTs with peaking resources using a competitive procurement process open to all resources.

948. The evidence does not supported inclusion of a new gas-fired combined cycle unit at Palo Seco by 2025 as part of a least cost plan.

949. The Energy Bureau accepts PREPA's assumptions in the record regarding wind, utility-scale battery storage, and utility- scale solar costs as reasonable for the purposes of this Proposed IRP.

950. The Energy Bureau finds that based on the evidence, PREPA's analysis of the DG resource using a fixed forecast is acceptable for the limited purposes for which it is used in this proceeding**.**

951. The Energy Bureau finds that based on the evidence, PREPA provided a reasonable analysis of the range of possible outcomes for natural gas prices and that its crude oil fuel price is reasonable.

952. The Energy Bureau does not approve the proposed gas infrastructure in the Proposed IRP because the evidence demonstrates no need for a new gas-fired CCGT at Palo Seco.

953. PREPA's Proposed IRP does consider environmental impact assessments. Nevertheless, in the next IRP cycle, PREPA shall expand the evaluation of environmental impacts, including a specific discussion of climate change aspects.

954. PREPA's inclusion of caveats and limitations as required by Section 2.03(I) of Regulation 9021 is reasonable, based on the evidence provided.

955. The evidence demonstrates that PREPA's scorecard as presented in the Proposed IRP is not useful and should be improved in the next IRP in accordance with the Energy Bureau's instructions.

956. The evidence demonstrates that microgrids form a critical part of the resiliency needs and that they should be incorporated into all of PREPA's transmission, distribution, and resource planning exercises and all deployment actions taken in compliance with the modified Action Plan.

957. PREPA has not demonstrated that all critical load must be served solely with thermal resources and PREPA has not provided evidence that solar PV and batteries are not able to supply a substantial portion of the actual critical load or that such resources could not provide contributions to the provision of a sufficient level of resiliency.

958. There is no evidentiary support for PREPA's capacity reserve requirement, whereby each of the eight MiniGrid regions must meet 75% of PREPA's forecast of as-defined "critical" peak load, with solely thermal capacity resources.

959. Intervenor testimony compellingly demonstrates the inherent value of small-scale distributed resources in the form of microgrids, single-site solar PV and battery storage,

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

and aggregated solar PV and battery storage (or VPPs) for Puerto Rico as a critical part of an overall solution to ensure resiliency.

960. The evidence demonstrates that the rapid deployment of points of distributed resiliency, including the use of microgrid, single-site solar PV and battery resources, or aggregated VPPs must form a part of PREPA's near-term approaches to developing a more resilient grid.

961. The evidence demonstrates that PREPA's VOLL analysis shows the importance of reducing longer-duration load loss, however, the analysis provides no comparison of the cost-effectiveness across different approaches to reduce such lost load.

962. PREPA has not supported or demonstrated its assertion that the overall MiniGrid construct is a "least cost" approach to achieving resiliency against weather events, given the lack of analysis of reasonable alternatives and of cost optimization of the MiniGrid construct.

963. The evidence demonstrates the need for transmission system upgrades and PREPA's plans to spend up to $2 billion for transmission hardening of existing elements and aging infrastructure

964. The evidence demonstrates that PREPA did not properly consider an optimized transmission plan and that the Modified Action Plan should include the development of a resource plan or implementation strategy to optimize transmission spending.

965. The evidence demonstrates that PREPA's plans for $911 million in distribution system investments for resiliency and support for DG is reasonable.

966. The evidence demonstrates that PREPA's preferred ESM Plan is not a least cost plan and should be rejected. The evidence further demonstrates that the Energy Bureau's modifications to the Preferred Resource Plan are just and reasonable and supported by the record.

967. The Energy Bureau properly modified PREPA's Action Plan as contained in its Proposed IRP consistent with the Energy Bureau's findings and orders as set forth throughout this Final Resolution and Order.

B. Conclusions of Law

968. Section 1.9 (1) of Act 17 -2019 states: "Long-term Electrical System planning is critical for implementing the Energy Public Policy set forth in this Act and furthering the sustainable development of the people of Puerto Rico through the Electrical System. Such planning shall consist of an Integrated Resource Plan consistent with the provisions of this Act, Act No. 57-2014 and Act No. 83." It further provides the Energy Bureau with the authority to approve the IRP.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

969. Section 1.9 (1) of Act 17 further states that the Energy Bureau "…shall evaluate and approve the Integrated Resource Plan and any amendments or modifications thereto in accordance with the legislative intent and the declaration of public policy adopted by the Legislative Assembly in Section 3 of Act 120, Section 13 of Act 29 with regards to the protections and considerations applicable to Partnership Contracts and the public interest declared herein." On June 17, 2020, the Energy Bureau issued a Resolution and Order issuing an Energy Compliance Certificate in accordance with Section 5(g) of Act 120-2018, for a PREPA transaction involving the operation and management of PREPA's T&D system.[1368] At the point when this transaction is completed and a new entity assumes responsibility for PREPA's T&D system, the Final Resolution and Order in this case will apply to the entity in the PREPA transaction that is responsible for the operation and management of PREPA's T&D system.

970. Article 6.3 (b) and (c) of Act 57 grants the Energy Bureau the authority to adopt and implement regulations necessary to "guarantee the capacity, reliability, safety, efficiency, and reasonability of electric rates." Pursuant to such provisions, the Energy Bureau adopted Regulation 9021, which sets forth the regulatory framework and filing requirements applicable to the submission by PREPA and the review by the Energy Bureau of PREPA's second Proposed IRP.

971. Section 1.9(3) of Act 17-2019 requires that the IRP contain: (i) a range of future demand forecasts; (ii) an evaluation of conservation resources available in the market; (iii) an evaluation of the range of conventional and non-conventional generation resources available in the market; (iv) an evaluation of transmission capacity and reliability of the system; (v) a comparative evaluation of energy supply resources including T&D; (vi) an evaluation of the combination of resources designated to promote energy diversification, stabilize energy costs and improve the stability and reliability of the grid; (vii) an evaluation of existing PREPA plants which estimates improvements in operational efficiency, useful lives, retirements and decommissioning costs; (viii) an evaluation of environmental impacts including air, water, solid waste and other environmental factors including climate change; (ix) an evaluation of the interconnection of renewable energy for compliance with Act 82-2010 and other independent power projects to PREPA's electricity system; an evaluation of climate change, projections with regard to the integration of distributed generation into the grid; an evaluation of essential service facilities across the Island and measures to increase resiliency such as through microgrids, distributed generation and underground distribution lines; an evaluation of the necessary actions to achieve energy storage goals; and, any other requirements established by the Energy Bureau through order or regulation.

[1368] Resolution and Order, In Re: Energy Compliance Certificate, Case No. NEPR-AP-2020-0002, June 17,2020.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

972. As required by Section 1.9(4) of Act 17, Article 6.23(c) of Act 57, and Regulation 9021, the Energy Bureau has reviewed the IRP. The Energy Bureau **APPROVES** in part and **DISAPPROVES** in part the IRP for the reasons stated in this Final Resolution and Order.

973. As required by Section 1.9(1) of Act 17, Article 6.23(c) of Act 57and Section 3.08 of Regulation 9021, the Energy Bureau is approving a Modified Integrated Resource Plan, and ordering PREPA to submit such document with certain elaborations and to take actions specified in Part V of this Final Resolution and Order to prepare for the next IRP.

VII. Conclusion

For all of the above, the Energy Bureau **APPROVES IN PART AND REJECTS IN PART** the Proposed IRP and **APPROVES** a Modified IRP and a Modified Action Plan, as described herein.

The Energy Bureau will publish this Final Resolution and Order in both, English and Spanish. If any conflict arises between the two versions, the English version shall prevail. Currently, the Energy Bureau is working on completing the Spanish version. However, for the benefit of the public, the Energy Bureau will publish today an Executive Summary of this Final Resolution and Order in the Spanish language.

Any party adversely affected by this Final Resolution and Order may file a motion for reconsideration before the Energy Bureau, pursuant to Section 11.01 of Regulation 8543,[1369] and the applicable provisions of Act 38-2017, known as the Uniform Administrative Procedures Act of the Government of Puerto Rico ("UAPA"). Said motion must be filed within twenty (20) days from the notification date of this Final Resolution and Order. Such request must be filed at the Energy Bureau Clerk's Office.

The Energy Bureau shall have fifteen (15) days from the date in which said motion is filed to consider it. Should the Energy Bureau rejects it forthright or fails to act upon it within said period of fifteen (15) days, the term to seek judicial review shall begin on the date in which the Energy Bureau notifies such denial or the date in which said fifteen (15)-day term expires, whichever occurs first. If the Energy Bureau considers the motion, the term to seek judicial review shall commence from the notification date of such determination. Such resolution shall be issued and filed in the record within ninety (90) days after the motion for reconsideration has been filed. If the Energy Bureau considers the motion to reconsider but takes no action regarding said motion within ninety (90) days of its filing, it shall lose jurisdiction on the motion and the term to seek judicial review shall commence upon the expiration of said ninety (90)-day term, unless the Energy Bureau, for just cause and within

[1369] *Regulation on Adjudicative, Notice of Noncompliance, Rate Review and Investigation Procedures*, Regulation No. 8543, December 18, 2014 ("Regulation 8543).

those ninety (90) days, extends the term to resolve for a period that shall not exceed thirty (30) days.

In the alternative, any affected party may file a petition for review before the Court of Appeals within a term of thirty (30) days from the notification date of this Final Resolution and Order. This in accordance with Section 11.03 of Regulation 8543, and the applicable provisions of the UAPA and the Court of Appeals Regulation.

Be it notified and published.

Edison Avilés Deliz
Chairman

Ángel R. Rivera de la Cruz
Associate Commissioner

Lillian Mateo Santos
Associate Commissioner

Ferdinand A. Ramos Soegaard
Associate Commissioner

CERTIFICATION

I hereby certify that the majority of the members of the Puerto Rico Energy Bureau has so agreed on August 21, 2020. I also certify that on August 24, 2020 a copy of this Resolution and Order was notified by electronic mail to: astrid.rodriguez@prepa.com; jorge.ruiz@prepa.com; n-vazquez@aeepr.com; c-aquino@prepa.com; mvazquez@diazvaz.law; axel.colon@aes.com; kbolanos@diazvaz.law; acarbo@edf.org; javier.ruajovet@sunrun.com; mgrpcorp@gmail.com; pedrosaade5@gmail.com; rmurthy@earthjustice.org; carlos.reyes@ecoelectrica.com; ccf@tcmrslaw.com; victorluisgonzalez@yahoo.com; hrivera@oipc.pr.gov; jrivera@cnslpr.com; manuelgabrielfernandez@gmail.com; acasellas@amgprlaw.com; corey.brady@weil.com; paul.demoudt@shell.com; escott@ferraiuoli.com; sproctor@huntonak.com; agraitfe@agraitlawpr.com; cfl@mcvpr.com; sierra@arctas.com; tonytorres2366@gmail.com; apagan@mpmlawpr.com info@liga.coop; amaneser2020@gmail.com; sboxerman@sidley.com; bmundel@sidley.com; gnr@mcvpr.com; rstgo2@gmail.com; larroyo@earthjustice.org; jluebkemann@earthjustice.org; loliver@amgprlaw.com; epo@amgprlaw.com; robert.berezin@weil.com; marcia.goldstein@weil.com; jonathan.polkes@weil.com; gregory.silbert@weil.com; maortiz@lvprlaw.com; rnegron@dnlawpr.com; castrodieppalaw@gmail.com; voxpopulix@gmail.com; paul.demoudt@shell.com; GiaCribbs@huntonak.com; aconer.pr@gmail.com; rtorbert@rmi.org; apagan@mpmlawpr.com; sboxerman@sidley.com; bmundel@sidley.com

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

I also certify that today; August 24; 2019; I have proceeded with the filing of the Resolution and Order issued by the Puerto Rico Energy Bureau and I have sent a true and exact copy to:

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NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
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NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

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I sign this in San Juan; Puerto Rico; today August 24, 2020.

Sonia Seda Gaztambide
Interim Clerk

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Appendix A. TIMELINE AND HISTORY OF THE PROCEEDING

974. PREPA's 2018-2019 IRP Filing has had an extensive history, which is outlined in detail in this Appendix A. For further detail on any of these filings, the Energy Bureau encourages readers to consult the IRP docket, CEPR-AP-2018-0001.

- **Commencement of the IRP Process.** March 15, 2018. The Energy Bureau initiated a proceeding for the filing of an updated IRP. The Energy Bureau determined that authorizing PREPA to file an updated IRP prior to the mandatory review established in Act 83 and Act 57 was appropriate in order to address the impacts of Hurricanes Irma and María on Puerto Rico's resource needs. In its Resolution and Order, the Energy Bureau authorized PREPA to commence Phase I of the process and to file an updated IRP on or about October 2018.1370 Phase 1 precedes the filing of the IRP and includes the "several months of information requests from the Energy Bureau, including specific modeling requirements, technical conferences" as you mention in the following bullet.[1371]
- **Filing of Initial 2018-2019 IRP.** February 13, 2019. PREPA filed its Initial 2018-2019 IRP.[1372]
- **Completeness Determination on Initial 2018-2019 IRP.** March 14, 2019. The Energy Bureau issued a resolution and order on the completeness of PREPA's IRP filing.[1373] The Energy Bureau determined that PREPA's proposed IRP was not in compliance with the Regulation 9021 and prior Energy Bureau orders. The Energy Bureau therefore required PREPA to re-file its proposed IRP to correct the deficiencies specified in the order and in detailed appendices to the order. The Energy Bureau required PREPA to refile its IRP within thirty (30) days from the date of the Order, requiring PREPA to justify any further delay within ten (10) days from the Order.[1374]

[1370] Resolution and Order, In Re: Commencement of Review Proceeding and Order Establishing Initial Submission Timeline, Case No. CEPR-AP-2018-0001, March 14, 2018, page 3.

[1371] *See* Regulation 9021, § 3.01.

[1372] PREPA's Petition and Informative Motion Regarding its Accompanying Integrated Resource Plan Filing, Case No. CEPR-AP-2018-0001, February 13, 2019, page 3.

[1373] Resolution and Order, In Re: Completeness of the Puerto Rico Electric Power Authority's Integrated Resource Plan Filing, Confidential Treatment of Portions of the Integrated Resource Plan, and Requested Waivers, Case No. CEPR-AP-2018-0001, March 14, 2019.

[1374] *Id.* at page 19.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

- **Proposed IRP.** June 7, 2019. After several requests for extensions, PREPA filed its updated IRP, stating that it included the IRP Main Report, plus two attachments (A and B) and Appendices 1-5, and required work papers.[1375]
- **Completeness Determination on Proposed 2018-2019 IRP**. On June 11, 2019, the Energy Bureau issued an order regarding PREPA's refiling of its IRP.[1376] In its order, the Energy Bureau determined that PREPA's filing was not complete, and required PREPA to file, on or before June 14, 2019, the missing pieces of the proposed IRP.[1377]
- **Filings to complete Proposed IRP**. June 14 - July 3, 2019. PREPA made filings to comply with the Energy Bureau's order over the course of several weeks[1378] during which time the Energy Bureau continued to discover parts of the IRP Filing that were missing.[1379]
- **Final Completeness Determination on Proposed IRP and Procedural Calendar and Beginning of Phase 2 of the IRP Process.** July 3, 2019. The Energy Bureau determined that the Proposed IRP Filing complied with the requirements of Regulation 9021 and determined that it was necessary to move to Phase 2 of the IRP approval process, pursuant to Regulation 9021.[1380] The Energy Bureau also set forth the schedule for the IRP process, setting the Evidentiary Hearing for October 22-25, 2019, a public hearing on November 26, 2019, and final comments by December 3, 2019.[1381] The Energy Bureau provided additional detail regarding the Evidentiary Hearing in a resolution on July 26, 2019.[1382]
- **Discovery Begins.** July 3, 2019. The Energy Bureau Staff, PREPA and approved Intervenors were given the opportunity to conduct discovery related to a diverse range of subjects related to PREPA's proposed IRP and intervenor testimony.

1375 PREPA's Cover Filing for Accompanying Compliance IRP Filing Due June 7, 2019, Case No. CEPR-AP-2018-0001, June 7, 2019.

1376 Resolution and Order, PREPA's Cover Filing for Accompanying Compliance IRP Filing Due June 7, 2019, Case No. CEPR-AP-2018-0001, June 11, 2019.

1377 *Id.*

1378 PREPA's Cover Filing, Updated List of Documents Filed or Submitted, and Motions, June 14, 2019, Case No. CEPR-AP-2018-0001; PREPA's Motion for Leave to File IRP Main Report "Errata" Version, Case No. CEPR-AP-2018-0001, June 19, 2019.

1379 *See, e.g.,* Resolution and Order, In Re: Documents Referenced in the Integrated Resource Plan and not included in the Filings, Case No. CEPR-AP-2018-0001, June 25, 2019.

1380 Resolution and Order, In Re: Completeness Determination of PREPA's IRP Filing and Procedural Calendar, Case No. CEPR-AP-2018-0001, July 3, 2019.

1381 *Id.*

1382 Resolution and Order, In Re: Appointment of Hearing Examiner, Initial Technical Hearing Format, Case No. CEPR-AP-2018-0001, July 26, 2019.

- Interventions. July 12, 2019 – August 9, 2019. The Energy Bureau granted intervention status for eighteen (18)[1383] intervenors: the Environmental Defense Fund; Sunrun, Inc.; Local Environmental Organizations (Comité de Dialogo Ambiental, Inc. El Puente Williamsburg, Inc. - Enlace Latino de Acción Climática, Comite Yabucoefio Pro-Calidad de Vida, Inc., Alianza, Comunitaria Ambientalista del Sureste, Inc., Sierra Club and its Puerto Rico Chapter, Mayagüezanos par la Salud y el Ambiente, Inc., Coalición de Organizaciónes AntiIncineracion, Inc. Amigos del Rio Guaynabo, Inc. Campamento Contra las Cenizas de Peñiuelas, Inc. and CAMBIO Puerto Rico); EcoEléctrica, L.P.; Grupo WindMar; Independent Office (OIPC); Empire Gas Company, Inc.; AES Puerto Rico, LP; National Public Finance Guarantee Corp.; Progression Energy; Shell NA LNG LLC; Wärtsilä North America; NFPs (Centro Unido de Detallistas (CUD); Cámara de Mercadeo, Industria y Distribución de Alimentos (MIDA); Puerto Rico Manufactures Association (PRMA); Cooperativa de Seguros Múltiples de Puerto Rico (CSMPR), Unidos Por Utuado (UPA), and el Instituto de Competitividad y Sostenibilidad Económica de Puerto Rico (ICSE-PR)); Caribe GE International Energy Services, Corp.; Solar and Energy Storage Association of Puerto Rico; League of Cooperatives of Puerto Rico and AMANESER 2025, Inc; and Arctas Capital Group, LP. The Energy Bureau also granted *Amicus Curiae* status to three entities: Rocky Mountain Institute; la Asociación de Consultores y Contratistas de Energía Renovable de Puerto Rico, Inc. (ACONER); and el Colegio de Ingenieros de Puerto Rico (CIAPR).
- **Technical Hearings.** August 13, 2019; September 4-5, 2019; The Energy Bureau held technical hearings to provide an opportunity for PREPA to share information on initial methodologies and assumptions regarding the IRP process and analysis. On August 9, 2019, the Energy Bureau amended its procedural schedule in response to a motion made by PREPA. Instead of a two-day initial technical hearing, the Energy Bureau held the first day of the Initial Technical Hearing for August 13, 2019, and set the second part of the Initial Technical Hearing for September 4, 2019, to continue to September 5, 2019, if necessary.[1384] The Energy Bureau held the first part of the initial Technical Hearing on August 13, 2019. On September 4-5, the Energy Bureau held the next part of the technical conference.[1385]
- **Earthquakes.** January 6 and 7, 2020. On the morning of January 6, a 5.8 magnitude earthquake struck the southern portion of the island, followed

[1383] The Energy Bureau also granted intervenor status to Renew Puerto Rico, but Renew Puerto Rico filed a motion to withdraw as an intervenor, and the Energy Bureau granted that request. *See* Resolution and Order, Motion to withdraw as an Intervenor in the IRP proceeding, Case No. CEPR-AP-2018-0001, November 4, 2019.

[1384] Resolution and Order, In Re: PREPA's Motion for Reconsideration Regarding Initial Technical Hearing Second Day Schedule, Case No. CEPR-AP-2018-0001, August 9, 2019.

[1385] Resolution and Order, In Re: Initial Technical Hearing, Procedural Calendar and Parties Notification Mailing List, Case No. CEPR-AP-2018-0001, August 21, 2019.

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

by a 6.4 magnitude earthquake on the morning of the 7th. These were followed by a series of significant earthquakes over the following several weeks. The earthquakes heavily impacted the island and its communities, and the January 7, 2020 earthquake caused severe damage to the Costa Sur generation plant.[1386] In response to motions to postpone the Evidentiary Hearing, the Energy Bureau determined that it would not change the date, noting that the first panel of the Evidentiary Hearing was scheduled to consider the impacts from the earthquake to the generation fleet, and that if the Energy Bureau determined at that time that additional modeling runs or information was needed, that it could extend the Evidentiary Hearing as needed. The Energy Bureau also noted the importance of completing the IRP process for the transformation of the Puerto Rico energy sector and for the economic development of Puerto Rico.[1387]

- **Evidentiary Hearing.** February 3-7, 2020. The Energy Bureau held an Evidentiary Hearing to consider PREPA's Proposed 2018-2019 IRP, and parties' testimony regarding the same. The hearing also considered the impact of the earthquakes on the IRP.
- **Public Hearings.** February 11, 13, 19, 22, and 25, 2020. The Energy Bureau, to ensure ample public participation with regards to the evaluation of the IRP, held five (5) public hearings in San Juan, Arecibo, Humacao, Mayagüez, and Ponce.[1388]
- **Intervenor Briefs.** March 6, 2020. Following the hearing, and several extensions, legal briefs were due and submitted by March 6, 2020.[1389] On March 13, 2020, in response to PREPA's Request for Extension of Time to File Reply to Legal Briefs, the Energy Bureau extended the time to file replies to March 20, 2020.1390 As a result of the coronavirus shutdown, reply briefs were filed on April 20, 2020.[1391]
- **Coronavirus Pandemic.** March 16, 2020. Pursuant to the Executive Order issued by Puerto Rico declaring an emergency due to the Covid-19 pandemic and establishing measures to prevent contamination, the Energy Bureau issued an Order closing its offices to the public business at the

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1386 Resolution, In Re: Not for Profit Intervenors' Motion of January 15, 2020, Case No. CEPR-AP-2018-0001, January 17, 2020.

1387 *Id.* at page 3.

1388 Resolution, In Re: Schedule for Public Hearings, Case No. CEPR-AP-2018-0001, January 17, 2020.

1389 Resolution, In Re: Extension of Final Substantive and Legal Briefs and Reply to Legal Briefs Deadlines, Case No. CEPR-AP-2018-0001, February 28, 2020.

1390 Resolution, In Re: PREPA's Request for Extension of Time to File Reply to Legal Briefs, Case No. CEPR-AP-2018-0001, March 13, 2020.

1391 Resolution and Order, In Re: Deadline for Reply to Final Briefs, Case No. CEPR-AP-2018-0001, April 15, 2020.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Energy Bureau until March 30, 2020. That Order was later extended through July 6, 2020. Notwithstanding the foregoing, the Energy Bureau maintained its operations remotely through the use of technology.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Appendix B. SUMMARY OF PUBLIC COMMENTS

975. In the interest of ensuring ample public participation and insight in the process, the Energy Bureau held five (5) public hearings as part of the proceeding. To provide further access to interested parties, all hearings were held in Spanish, four (4) hearings were held outside the metropolitan area in different parts across the Island, and one (1) hearing was held in San Juan. Additionally, all public hearings were live streamed and recorded. The first hearing was held on February 11, 2020, at the Energy Bureau's Hearing Room, located in the World Plaza Building, 8th Floor, San Juan, Puerto Rico. A total of twenty (20) participants deposed before the Energy Bureau. The second hearing was held on February 13, 2020, at the facilities of the CIAPR in Arecibo. A total of thirteen (13) participants deposed before the Energy Bureau. The third hearing was held on February 19, 2020, at the facilities of the CIAPR in Humacao. A total of twenty-two (22) participants deposed before the Energy Bureau. The fourth hearing was held on February 22, 2020, at the facilities of the CIAPR in Mayagüez. A total of twenty-two (22) participants deposed before the Energy Bureau. The fifth hearing was held on February 25, 2020, at the facilities of the CIAPR in Ponce. A total of twelve (12) participants deposed before the Energy Bureau.

976. During these hearings, the Energy Bureau heard comments from the public regarding an ample list of concerns, which included the following issues.

977. From the participation of the citizens, there was a general sentiment of rejection to the IRP as presented and proposed by PREPA. In general terms, participants argued that the elaboration of a plan such as the IRP should have ample public participation since the beginning stages of development, and not be limited to the participation of the general public when the plan has already been developed and is under evaluation by the Energy Bureau. Specifically, many participants argued that the communities that could be directly impacted by the development of new generation infrastructure were not considered, or made aware, of PREPA's plans. Therefore, the majority of the citizens that participated at the public hearings reject the development and investment in new generation infrastructure that use fossil fuels as a resource. Additionally, it is the public perception that said investment would delay unnecessarily the integration of renewable energy resources in Puerto Rico. However, some participants explained that in order to have an orderly and systematic transition to renewable energy that does not attempt against the stability of the electric grid, a portion of Puerto Rico's generation will need to come from centralized fossil fuel generation plants until they can be transitioned out of the electric grid.

978. Specifically, there was a general concern among the participants that PREPA's IRP does not provide any specific plans for the integration of renewable energy across

the twenty (20) year planning horizon. Citizens expressed that PREPA's IRP does not comply with Puerto Rico's energy public policy, as established by Act 17-2019, which calls for the elimination of the use of fossil fuels as a resource for energy generation and the goal of achieving one hundred percent (100%) renewable energy by 2050. Further, most of the participants were in favor of increasing the integration of renewable energy through the use of rooftop solar, instead of the use of utility scale solar generation. Citizens argued that the development of utility scale solar generation does not take into consideration the impact in different types of soil around the Island, specifically soil used for agricultural purposes.

979. Regarding the use of rooftop solar as an option for the integration of renewable energy, many participants were willing to invest on residential systems for purposes of having reliable electric service. Other participants suggested that PREPA should provide incentives to residential customers for them to be able to acquire such systems or develop a program for the deployment of rooftop solar.

980. Also, regarding the integration of renewable energy generation, many participants suggested that the use of Puerto Rico's hydroelectric power plants were not given the importance they have in been able to provide reliable electric service. Additional investments in hydro plants should be done in order to fully take advantage of the benefits these systems can provide, such as having black-start capabilities to bring back online the electric system after major outages, such as after Hurricane María.

981. Participants also argued that the implementation of EE programs should be assessed and incorporated prior to investing in new fossil fuel generation infrastructure that may not be needed.

982. Many deponents indicated the need for the IRP to more carefully address issues such as climate change. Participants argued that PREPA's IRP does not comply with environmental laws and does not provide a profound analysis on the impact that new fossil fuel infrastructure may have in nearby communities. From the participants point of view, there is no evaluation of environmental impacts, or mitigation and adaptation processes. There is no evaluation of the risks associated with developing these new infrastructures, or with the use of natural gas as the resource for energy generation. Many participants were concerned with the risks associated to building natural gas pipelines in strips of land that are populated and provided examples of gas pipelines around the world that have encountered faults that have resulted in explosions and fires of great proportion.

983. Moreover, participants argued that PREPA's IRP does not consider the impact that the increase in maritime traffic for ships to provide fuel to new generation plants may have in the coastline environment, affecting reefs, marine species, as well as fishing areas. Also, participants questioned if PREPA had evaluated a possible increase in maritime traffic and the prioritization of entrance to the San Juan Bay.

984. Finally, citizens were profoundly concerned about the IRP not considering the health risks associated with the construction of new fossil fuel generation infrastructure near populated areas. Participants alleged that such developments may increase the probability of health concerns, such as an increase of cancer patients, in said communities.

Appendix C. RESOURCE SCENARIO MODELING RESULTS

Table C-1. NPVRR – All Scenarios Summary

Scenario	Filing	NPV $Millions	ENS $Millions	NPV+ENS $Millions	PV-2025 MW	PV–2038 MW	BESS–2025 MW	BESS–2038 MW
S1S2B	Original	14,774	214	14,988	2,580	2,700	1,280	1,720
S1S2H	Original	16,124	393	16,516	2,820	3,180	1,360	1,840
S1S2L	Original	13,525	264	13,789	2,340	2,340	1,240	1,800
S1S3B	Original	14,688	486	15,173	2,580	2,580	1,280	1,840
S1S2S1B	Original	14,450	214	14,664	2,580	2,700	1,280	1,720
S1S2S5B	Original	15,378	214	15,593	2,580	2,700	1,280	1,720
S1S2S6B	Original	16,019	214	16,233	2,580	2,700	1,280	1,720
S1S2S7B	Original	15,686	423	16,108	2,880	3,240	1,280	1,760
S1S1B	Original	14,356	1,151	15,506	2,520	2,520	1,240	2,080
S3S2B	Original	13,843	206	14,049	2,820	4,140	1,400	3,040
S3S2H	Original	15,292	658	15,950	3,300	4,560	1,680	2,600
S3S2L	Original	13,354	418	13,772	3,000	4,080	1,600	2,520
S3S3B	Original	14,539	326	14,865	2,820	4,140	1,280	2,280
S3S2S5B	Original	14,812	206	15,018	2,820	4,140	1,400	3,040
S3S2S8B	Original	14,358	206	14,563	2,820	4,140	1,400	3,040
S4S2B	Original	14,339	247	14,587	2,220	2,820	1,320	1,640
S4S2H	Original	15,144	319	15,463	2,460	2,520	940	980
S4S2L	Original	12,854	198	13,052	2,100	2,520	960	1,020
S4S2S9B	Original	14,469	268	14,737	2,220	2,820	1,320	1,640
S4S3B	Original	14,405	279	14,685	2,580	2,820	1,320	1,320
S4S2S1B	Original	14,001	247	14,249	2,220	2,820	1,320	1,640
S4S2S4B	Original	14,638	346	14,984	2,580	3,060	1,320	1,640
S4S2S5B	Original	15,244	247	15,492	2,220	2,820	1,320	1,640
S4S2S6B	Original	15,554	247	15,802	2,220	2,820	1,320	1,640
S4S1B	Original	14,028	1,109	15,137	2,700	2,700	1,240	1,640
S5S1B	Original	14,112	593	14,705	2,580	2,580	1,200	1,480
S5S1S5B	Original	15,649	593	16,243	2,580	2,580	1,200	1,480
S5S1S1B	Original	13,802	593	14,395	2,580	2,580	1,200	1,480
S5S1S6B	Original	15,325	593	15,918	2,580	2,580	1,200	1,480
ESM	Original	14,420	267	14,687	2,400	2,580	920	1,640
ESM High	Original	15,244	465	15,709	2,340	2,460	1,040	1,040
ESM Low	Original	13,941	202	14,144	1,920	1,980	1,040	1,040

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Scenario	Filing	NPV $Millions	ENS $Millions	NPV+ENS $Millions	PV-2025 MW	PV–2038 MW	BESS–2025 MW	BESS–2038 MW
ESMS1B	Original	14,110	267	14,377	2,400	2,580	920	1,640
ESMS6B	Original	15,581	267	15,848	2,400	2,580	920	1,640
ESMS5B	Original	15,601	267	15,868	2,400	2,580	920	1,640
S3S2S6B	ROI 6-2	16,098	206	16,304	2,820	4,140	1,400	3,040
S3S2S6H	ROI 6-2	17,784	658	18,442	3,300	4,560	1,680	2,600
S3S2S6L	ROI 6-2	15,584	418	16,002	3,000	4,080	1,600	2,520
S3S2S8H	ROI 6-2	15,864	658	16,523	3,300	4,560	1,680	2,600
S3S2S8L	ROI 6-2	13,861	418	14,279	3,000	4,080	1,600	2,520
ESMS10B	ROI 6-3	15,277	327	15,604	2,460	2,520	880	1,440
S4S2S10B	ROI 6-3	16,088	614	16,702	2,940	3,060	1,360	1,640
S3S2S10B	ROI 6-3	15,853	470	16,323	3,300	4,440	1,360	2,520
S3S2S11B	ROI 6-4	14,580	572	15,152	2,220	4,140	1,360	3,040
S4S2S12B	ROI 6-5	14,760	409	15,169	2,520	3,060	1,320	1,560
ESMS12B	ROI 6-5	14,552	267	14,819	2,400	2,580	920	1,640
S4S2S13B	ROI 6-6	14,266	247	14,513	2,220	2,820	1,320	1,640
ESMS13B	ROI 6-6	14,382	267	14,649	2,400	2,580	920	1,640
ESMS5B_actPriceNFE	ROI 7-1	14,476	267	14,743	2,400	2,580	920	1,640
S3S2_nolimits	ROI 7-2	14,222	145	14,367	3,960	4,140	1,840	3,040
S4S2_nolimits	ROI 7-2	14,882	359	15,241	3,480	3,480	1,960	2,120
S4S1H	ROI 7-3	15,258	1,158	16,416	2,880	3,060	1,240	1,640
S4S1L	ROI 7-3	13,196	927	14,123	2,940	3,000	1,320	1,640
S3S2B_SJConvFix	ROI 8-1	13,789	343	14,132	2,820	4,140	1,400	3,040
S3S2 NoEE	ROI 9-1	16,495	401	16,896	3,900	5,520	1,650	3,050
ESM NoEE	ROI 9-1	17,328	194	17,522	3,060	4,200	1,160	2,040
S4S2 NoEE	ROI 9-1	17,633	494	18,127	3,300	4,200	1,520	2,120
S5S1 NoEE	ROI 9-1	17,676	736	18,412	3,480	4,200	1,520	2,120
S1S2 NoEE	ROI 9-1	18,121	665	18,786	3,480	4,620	1,520	2,320
S3S2 LowEE	ROI 9-1	16,010	601	16,611	3,900	5,640	1,480	3,040
ESM LowEE	ROI 9-1	16,393	409	16,802	3,060	3,840	1,480	1,960
S4S2 LowEE	ROI 9-1	16,556	500	17,055	3,300	3,840	1,480	1,920
S5S1 LowEE	ROI 9-1	16,585	681	17,267	3,360	3,840	1,480	2,080
S1S2 LowEE	ROI 9-1	17,176	524	17,701	3,300	4,200	1,480	1,840
S3S2B_adjusted	ROI 9-3	13,858	206	14,064	2,820	4,140	1,400	3,040
S4S2B_adjusted	ROI 9-3	14,353	247	14,601	2,220	2,820	1,320	1,640
S3S2S8B_adjusted	ROI 9-3	14,824	451	15,274	2,820	4,140	1,400	3,040
S3S2 NoEE Eco	ROI 10-5	16,742	608	17,350	3,900	5,580	1,520	3,040
S4S2 NoEE Eco	ROI 10-5	17,739	386	18,125	3,300	4,200	1,520	2,040

Scenario	Filing	NPV $Millions	ENS $Millions	NPV+ENS $Millions	PV-2025 MW	PV–2038 MW	BESS–2025 MW	BESS–2038 MW
S1S2 NoEE PPA	ROI 10-5	18,806	548	19,354	3,480	5,580	1,520	2,000
S5S1 NoEE PPOA	ROI 10-5	17,464	982	18,446	3,060	4,200	1,440	2,000
S3S2 NoEE Eco PVNoLimit	ROI 10-5	16,950	397	17,347	5,220	5,760	1,720	3,040
S4S2 NoEE Eco PVNoLimit	ROI 10-5	18,552	431	18,984	4,680	5,280	2,000	2,640
S3S2 LowEE Eco	ROI 10-5	15,978	564	16,543	3,540	5,640	1,480	3,040
S4S2 LowEE Eco	ROI 10-5	16,679	494	17,173	3,300	3,840	1,480	1,920
S5S1 LowEE PPOA	ROI 10-5	16,736	1,050	17,787	3,300	4,200	1,440	2,000
S1S2 LowEE PPA	ROI 10-5	17,465	511	17,976	3,480	5,160	1,560	2,600
S3S2 LowEE Eco PVNoLimit	ROI 10-5	16,125	373	16,497	5,220	5,760	1,720	3,040
S4S2 LowEE Eco PVNoLimit	ROI 10-5	17,283	423	17,706	4,380	4,620	1,760	2,320
S3S2B Eco	ROI 10-5	14,144	646	14,790	3,060	4,440	1,360	3,040
S4S2B Eco	ROI 10-5	14,824	155	14,979	2,580	3,060	1,360	1,560
1a – IRP load – early conversion	AES ROI-1	15,702	594	16,296	2,220	3,060	1,320	1,880
5941b – IRP load – early retire no conversion	AES ROI-1	15,682	208	15,890	2,220	3,060	1,320	1,880
2a – IRP load – late conversion	AES ROI-1	14,951	406	15,357	2,220	3,060	1,200	1,880
1c – low EE load – early conversion	AES ROI-1	17,310	581	17,891	2,220	3,840	1,440	2,080
1d – low EE ld early retire no conversion	AES ROI-1	17,412	573	17,985	2,220	3,840	1,440	2,080
2b– low EE load – late conversion	AES ROI-1	16,800	652	17,452	2,220	3,840	1,320	1,960

Source: PREPA IRP Exhibit 8-3 and Metrics Files in response to Energy Bureau-PREPA ROIs 6-2, 6-3, 6-4, 6-5, 6-6, 7-1, 7-2, 7-3, 8-1, 9-1, 9-3, 10-5; and in response to AES-PREPA ROI 1-1.

Table C-2. Scenario Additions – Originally Filed Scenarios from IRP Exhibit 8-1

Scenario	F - Class Palo Seco 2025	F - Class Costa Sur 2025	F-Class Yabucoa 2025	Mayagüez Peaker Conversion	Other	Peakers 2025 (MW)	New Solar 2025 (MW)	BESS 2025 (MW)	New Solar 2038 (MW)	BESS 2038 (MW)
S1S2B	–	EcoEl Instead	–	–	–	559	2,580	1,280	2,700	1,720
S1S2H	–	EcoEl Instead	–	–	Costa Sur 5 to 2034	325	2,820	1,360	3,180	1,840
S1S2L	–	EcoEl Instead	–	–	–	325	2,340	1,240	2,340	1,800
S1S3B	–	EcoEl Instead	–	–	–	513	2,580	1,280	2,580	1,840
S1S2S1B	–	EcoEl Instead	–	–	–	504	2,580	1,280	2,700	1,720
S1S2S5B	–	EcoEl Instead	–	–	–	504	2,580	1,280	2,700	1,720
S1S2S6B	–	EcoEl Instead	–	–	–	504	2,580	1,280	2,700	1,720
S1S2S7B	–	EcoEl Instead	–	–	Costa Sur 5 to 2036	507	2,880	1,280	3,240	1,760
S1S1B	✔	✔	X	X	Costa Sur 5&6 to 2037 & 2031	302	2,520	1,240	2,520	2,080
S3S2B	–	✔	–	–	–	348	2,820	1,320	4,140	3,040
S3S2H	–	✔	–	–	–	364	3,300	1,680	4,560	2,600
S3S2L	–	–	–	–	–	389	3,000	1,600	4,080	2,520
S3S3B	–	✔	–	–	–	371	2,820	1,280	4,140	2,280
S3S2S5B	–	✔	–	–	–	348	2,820	1,280	4,140	2,280
S3S2S8B	–	✔	–	–	–	348	2,820	1,280	4,140	2,280
S4S2B	✔	✔	–	–	–	371	2,220	1,320	2,820	1,640
S4S2H	✔	✔	–	–	–	394	2,460	940	2,520	980
S4S2L	–	✔	–	–	–	434	2,100	960	2,520	1,020
S4S2S9B	✔	EcoEl Instead	X	X	X	348	2,220	1,320	2,820	1,640
S4S3B	2027	✔	–	–	–	394	2,580	1,320	2,820	1,320
S4S2S1B	✔	✔	–	–	–	371	2,220	1,320	2,820	1,640
S4S2S4B	–	✔	–	–	–	371	2,580	1,320	3,060	1,640
S4S2S5B	✔	✔	–	–	–	371	2,220	1,320	2,820	1,640
S4S2S6B	✔	✔	–	–	–	371	2,220	1,320	2,820	1,640
S4S1B	–	–	2028	–	F-Class at Mayguez 2025	348	2,700	1,240	2,700	1,640
S5S1B	–	369 MW (2025&2028)	–	–	–	371	2,580	1,200	2,580	1,480
S5S1S5B	–	369 MW (2025&2028)	–	–	–	371	2,580	1,200	2,580	1,480

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Scenario	F - Class Palo Seco 2025	F - Class Costa Sur 2025	F-Class Yabucoa 2025	Mayagüez Peaker Conversion	Other	Peakers 2025 (MW)	New Solar 2025 (MW)	BESS 2025 (MW)	New Solar 2038 (MW)	BESS 2038 (MW)
S5S1S1B	–	369 MW (2025&2028)	–	–	–	371	2,580	1,200	2,580	1,480
S5S1S6B	–	369 MW (2025&2028)	–	–	–	371	2,580	1,200	2,580	1,480
ESM	✔	EcoEl Instead	✔	✔	–	421	2,400	920	2,580	1,640
ESM High	✔	EcoEl Instead	✔	✔	–	421	2,340	1,040	2,460	1,040
ESM Low	✔	EcoEl Instead	✔	✔	–	421	1,920	1,040	1,980	1,040
ESMS1B	✔	EcoEl Instead	✔	✔	–	421	2,400	920	2,580	1,640
ESMS6B	✔	EcoEl Instead	✔	✔	–	421	2,400	920	2,580	1,640
ESMS5B	✔	EcoEl Instead	✔	✔	–	421	2,400	920	2,580	1,640

Source: PREPA IRP Exhibit 8-1.

Table C-3. Scenario Retirements - Originally Filed Scenarios from IRP Exhibit 8-2

AES 1 & 2	Aguirre Steam 1 & 2	Aguirre CC 1 & 2	Costa Sur 5 & 6	EcoEléctrica	Palo Seco 3 & 4	San Juan 5 & 6	San Juan 5 & 6 Conv	San JuB3:J28an 7 & 8
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2019 2 - 2020	5 - 2020 6 - 2022	Not Retired	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2033	7 - 2021 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2020 2 - 2020	5 - 2034 6 - 2020	Not Retired	3 - 2022 4 - 2023	5 - 2019 6 - 2019	6 - 2035	7 - 2023 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2020 2 - 2021	5 - 2020 6 - 2020	Not Retired	3 - 2023 4 - 2021	5 - 2019 6 - 2019	5 - 2037 6 - 2030	7 - 2021 8 - 2023
1 - 2027 2 - 2027	1 - 2020 2 - 2020	1 - 2019 2 - 2020	5 - 2019 6 - 2021	Not Retired	3 - 2022 4 - 2023	5 - 2019 6 - 2019	5 - 2037 6 - 2031	7 - 2021 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2019 2 - 2020	5 - 2020 6 - 2022	Not Retired	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2033	7 - 2021 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2019 2 - 2020	5 - 2020 6 - 2022	Not Retired	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2033	7 - 2021 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2019 2 - 2020	5 - 2020 6 - 2022	Not Retired	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2033	7 - 2021 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2020 2 - 2020	5 - 2036 6 - 2021	Not Retired	3 - 2022 4 - 2023	5 - 2023 6 - 2037	N/A	7 - 2022 8 - 2021
1 - 2027 2 - 2027	1 - 2019 2 - 2020	1 - 2021 2 - 2020	5 - 2037 6 - 2031	Not Retired	3 - 2019 4 - 2019	5 - 2019 6 - 2019	5 - 2036 6 - 2035	7 - 2019 8 - 2019
1 - 2027 2 - 2027	1 - 2019 2 - 2023	1 - 2020 2 - 2020	5 - 2021 6 - 2019	2024	3 - 2021 4 - 2023	5 - 2034 6 - 2020	5 - 2033 6 - 2030	7 - 2023 8 - 2020

NEGOCIADO DE ENERGÍA DE PUERTO RICO NEPR JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

AES 1 & 2	Aguirre Steam 1 & 2	Aguirre CC 1 & 2	Costa Sur 5 & 6	EcoEléctrica	Palo Seco 3 & 4	San Juan 5 & 6	San Juan 5 & 6 Conv	San JuB3:J28an 7 & 8
1 - 2027 2 - 2027	1 - 2020 2 - 2020	1 - 2019 2 - 2019	5 - 2021 6 - 2021	2024	3 - 2022 4 - 2023	5 - 2021 6 - 2023	5 - 2033 6 - 2029	7 - 2023 8 - 2020
1 - 2027 2 - 2027	1 - 2021 2 - 2021	1 - 2019 2 - 2019	5 - 2020 6 - 2020	2024	3 - 2023 4 - 2021	5 - 2019 6 - 2023	5 - 2032 6 - 2029	7 - 2019 8 - 2021
1 - 2027 2 - 2027	1 - 2021 2 - 2020	1 - 2019 2 - 2019	5 - 2020 6 - 2021	2024	3 - 2022 4 - 2023	5 - 2022 6 - 2023	5 - 2033 6 - 2030	7 - 2020 8 - 2019
1 - 2027 2 - 2027	1 - 2019 2 - 2023	1 - 2020 2 - 2020	5 - 2021 6 - 2019	2024	3 - 2021 4 - 2023	5 - 2034 6 - 2020	5 - 2033 6 - 2030	7 - 2023 8 - 2020
1 - 2027 2 - 2027	1 - 2019 2 - 2023	1 - 2020 2 - 2020	5 - 2021 6 - 2019	2024	3 - 2021 4 - 2023	5 - 2034 6 - 2020	5 - 2033 6 - 2030	7 - 2023 8 - 2020
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2025	5 - 2020 6 - 2020	2024	3 - 2025 4 - 2023	5 - 2019 6 - 2019	6 - 2034	7 - 2023 8 - 2023
1 - 2027 2 - 2027	1 - 2020 2 - 2019	1 - 2025	5 - 2029 6 - 2020	2024	3 - 2025 4 - 2025	5 - 2019 6 - 2019	6 - 2034	7 - 2023 8 - 2023
1 - 2027 2 - 2027	1 - 2020 2 - 2019	1 - 2025 2 - 2032	5 - 2019 6 - 2020	2024	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2034	7 - 2023 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2025	5 - 2020 6 - 2020	Not Retired	3 - 2025 4 - 2023	5 - 2019 6 - 2019	6 - 2034	7 - 2023 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2029	5 - 2020 6 - 2020	2024	3 - 2022 4 - 2023	5 - 2019 6 - 2019	5 - 2036 6 - 2032	7 - 2021 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2025	5 - 2020 6 - 2020	2024	3 - 2025 4 - 2023	5 - 2019 6 - 2019	6 - 2034	7 - 2023 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2033	5 - 2020 6 - 2024	2024	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2034	7 - 2019 8 - 2019
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2025	5 - 2020 6 - 2020	2024	3 - 2025 4 - 2023	5 - 2019 6 - 2019	6 - 2034	7 - 2023 8 - 2023
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2025	5 - 2020 6 - 2020	2024	3 - 2025 4 - 2023	5 - 2019 6 - 2019	6 - 2034	7 - 2023 8 - 2023
1 - 2027 2 - 2027	1 - 2020 2 - 2019	1 - 2032 2 - 2025	5 - 2022 6 - 2020	2024	3 - 2019 4 - 2019	5 - 2019 6 - 2019	5 - 2035 6 - 2030	7 - 2019 8 - 2019
1 - 2027 2 - 2027	1 - 2019 2 - 2020	1 - 2033 2 - 2025	5 - 2020 6 - 2019	2024	3 - 2023 4 - 2022	5 - 2019 6 - 2019	5 - 2031 6 - 2026	7 - 2023 8 - 2021
1 - 2027 2 - 2027	1 - 2019 2 - 2020	1 - 2033 2 - 2025	5 - 2020 6 - 2019	2024	3 - 2023 4 - 2022	5 - 2019 6 - 2019	5 - 2031 6 - 2026	7 - 2023 8 - 2021
1 - 2027 2 - 2027	1 - 2019 2 - 2020	1 - 2033 2 - 2025	5 - 2020 6 - 2019	2024	3 - 2023 4 - 2022	5 - 2019 6 - 2019	5 - 2031 6 - 2026	7 - 2023 8 - 2021
1 - 2027 2 - 2027	1 - 2019 2 - 2020	1 - 2033 2 - 2025	5 - 2020 6 - 2019	2024	3 - 2023 4 - 2022	5 - 2019 6 - 2019	5 - 2031 6 - 2026	7 - 2023 8 - 2021

AES 1 & 2	Aguirre Steam 1 & 2	Aguirre CC 1 & 2	Costa Sur 5 & 6	EcoEléctrica	Palo Seco 3 & 4	San Juan 5 & 6	San Juan 5 & 6 Conv	San JuB3:J28an 7 & 8
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2032	5 - 2020 6 - 2020	Not Retired	3 - 2025 4 - 2025	5 - 2019 6 - 2019	5 - 2035 6 - 2025	7 - 2023 8 - 2021
1 - 2027 2 - 2027	1 - 2022 2 - 2019	1 - 2025 2 - 2025	5 - 2021 6 - 2020	Not Retired	3 - 2025 4 - 2021	5 - 2019 6 - 2019	5 - 2036 6 - 2025	7 - 2025 8 - 2022
1 - 2027 2 - 2027	1 - 2022 2 - 2019	1 - 2025 2 - 2028	5 - 2020 6 - 2020	Not Retired	3 - 2022 4 - 2025	5 - 2019 6 - 2019	5 - 2033 6 - 2025	7 - 2021 8 - 2025
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2032	5 - 2020 6 - 2020	Not Retired	3 - 2025 4 - 2025	5 - 2019 6 - 2019	5 - 2035 6 - 2025	7 - 2023 8 - 2021
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2032	5 - 2020 6 - 2020	Not Retired	3 - 2025 4 - 2025	5 - 2019 6 - 2019	5 - 2035 6 - 2025	7 - 2023 8 - 2021
1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2032	5 - 2020 6 - 2020	Not Retired	3 - 2025 4 - 2025	5 - 2019 6 - 2019	5 - 2035 6 - 2025	7 - 2023 8 - 2021

Source: PREPA IRP Exhibit 8-2.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Table C-4. PREPA Summary of Key Modeling Results – Capacity Additions (Energy Bureau-PREPA ROI-9-1)

	Large and Medium CCGTs and Peakers							Renewable and Storage				
Case ID	F - Class Palo Seco 2025	F - Class Costa Sur 2025	San Juan 5&6 Conversion	F-Class Yabucoa 2025	Mayagüez Peaker Conversion	Other	Peakers 2025 (MW)	New Solar 2025 (MW)	BESS 2025 (MW)	New Solar 2038 (MW)	BESS 2038 (MW)	Customer Owned Generation 2038 (MW)
ESM No EE	**2025**	Eco instead New PPOA	✔	✔	✔	**X**	621	3,060	1,160	4,200	2,040	1,176
ESM Low EE	**2025**	Eco instead New PPOA	✔	✔	✔	**X**	621	3,060	1,480	3,840	1,960	1,176
S4S2B No EE	**2028**	Eco instead New PPOA	✔	**NO**	**NO**	**X**	474	3,300	1,520	4,200	2,120	1,176
S4S2B Low EE	**2028**	Eco instead New PPOA	✔	**NO**	**NO**	**X**	410	3,300	1,480	3,840	1,920	1,176
S3S2B No EE	**NO**	Eco instead New PPOA	✔	**NO**	**NO**	**X**	450	3,900	1,640	5,520	3,040	1,176
S3S2B Low EE	**NO**	Eco instead New PPOA	✔	**NO**	**NO**	**X**	387	3,900	1,480	5,640	3,040	1,176
S1S2B No EE	**NO**	Eco instead New PPOA	✔	**NO**	**NO**	**X**	524	3,480	1,520	4,620	2,320	1,176
S1S2B Low EE	**NO**	Eco instead New PPOA	✔	**NO**	**NO**	**X**	380	3,300	1,480	4,200	1,840	1,176
S5S1B No EE	**NO**	Eco instead New PPOA	✔	**NO**	**NO**	**Costa Sur CCGT**	524	3,480	1,520	4,200	2,120	1,176
S5S1B Low EE	**NO**	Eco instead New PPOA	✔	**NO**	**NO**	**Costa Sur CCGT**	426	3,360	1,480	3,840	2,080	1,176

Source: PREPA additional responses to Energy Bureau-PREPA ROI 9-1, Table 3, Summary of Capacity Additions All Scenarios", page 12, December 6, 2019.

Table C-5. PREPA Summary of Key Modeling Results – Capacity Additions (Energy Bureau-PREPA ROI-10-5)

Case ID	F - Class Palo Seco	F - Class Costa Sur	San Juan 5&6 Conversion	F-Class Yabucoa 2025	Mayagüez Peker Conversion	Other	Peakers 2025 (MW)	New Solar 2025 (MW)	BESS 2025 (MW)	New Solar 2038 (MW)	BESS 2038 (MW)	Customer Owned Generation 2038 (MW)
S4S2B NO EE w/ PPOA	**2028**	✔ (2033)	✔	**X**	**X**	**X**	458	3,300	1,520	4,200	2,040	1,176
S4S2B Low EE w/ PPOA	**2028**	✔ (2033)	✔	**X**	**X**	**X**	403	3,300	1,480	3,840	1,920	1,176
S4S2B Base w/ PPOA	**2025**	X	✔	**X**	**X**	**X**	394	2,580	1,360	3,060	1,560	1,176
S4S2B NO EE w/ PPOA, No Solar limits	**2028**	✔ (2033)	✔	**X**	**X**	**X**	490	4,680	2,000	5,280	2,640	1,176
S4S2B Low EE w/ PPOA, No Solar limits	**2028**	X	✔	**X**	**X**	**X**	415	4,380	1,760	4,620	2,320	1,176
S1S2B Low EE w/ PPOA	**X**	X	✔	**X**	**X**	**X**	380	3,480	1,560	5,160	2,600	1,176
S1S2B NO EE w/ PPOA	**X**	**X**	✔	**X**	**X**	**X**	515	3,480	1,520	5,580	2,000	1,176
S3S2B_Base_ w/ PPOA	**X**	**X**	✔	**X**	**X**	**X**	371	3,060	1,360	4,440	3,040	1,176
S3S2B NO EE w/ PPOA	**X**	✔ (2033)	✔	**X**	**X**	**X**	394	3,900	1,520	5,580	3,040	1,176
S3S2B Low EE w/ PPOA	**X**	✔ (2033)	✔	**X**	**X**	**X**	371	3,540	1,480	5,640	3,040	1,176
S3S2B Low EE w/ PPOA_no Solar Limits	**X**	✔ (2033)	✔	**X**	**X**	**X**	418	5,220	1,720	5,760	3,040	1,176
S3S2B NO EE w/ PPOA no Solar Limits	**X**	✔ (2033)	✔	**X**	**X**	**X**	418	5,220	1,720	5,760	3,040	1,176
S5S1B Low EE w PPOA	**2034**	✔ (2033)	✔	**X**	**X**	**X**	348	3,300	1,360	4,200	1,720	1,176
S5S1B No EE w PPOA (r1)	**2025**	✔ (2033)	✔	**2028**	**X**	**X**	348	3,060	1,400	4,200	1,920	1,176

Source: PREPA response to Energy Bureau-PREPA ROI-10-5, Table 3, Summary of Capacity and Additions All Scenarios, page 11, January 22, 2020.

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Table C-6. PREPA Summary of Key Modeling Results – Capacity Retirements (Energy Bureau-PREPA ROI-9-1)

	Large Thermal Retirements								
Case ID	**AES 1 & 2**	**Aguirre Steam 1 & 2**	**Aguirre CC 1 & 2**	**Costa Sur 5 & 6**	**EcoEléctrica**	**Palo Seco 3 & 4**	**San Juan 5 & 6**	**San Juan 5 & 6 Conv**	**San Juan 7 & 8**
ESM No EE	1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2025	5 - 2021 6 - 2020	not retired	3 - 2025 4 - 2025	5 - 2019 6 - 2019	not retired	7 - 2023 8 - 2023
ESM Low EE	1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 - 2025	5 - 2021 6 - 2020	not retired	3 - 2023 4 - 2024	5 - 2019 6 - 2019	6 - 2025	7 - 2021 8 - 2023
S4S2B No EE	1 - 2027 2 - 2027	1 - 2019 2 - 2020	1 - 2025	5 - 2021 6 - 2020	not retired	3 - 2023 4 - 2021	5 - 2019 6 - 2019	6 - 2025	7 - 2023 8 - 2022
S4S2B Low EE	1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025	5 - 2020 6 - 2020	not retired	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2025	7 - 2022 8 - 2023
S3S2B No EE	1 - 2027 2 - 2027	1 - 2020 2 - 2019	1 - 2019	5 - 2021 6 - 2020	not retired	3 - 2023 4 - 2021	5 - 2019 6 - 2019	6 - 2034	7 - 2023 8 - 2022
S3S2B Low EE	1 - 2027 2 - 2027	1 - 2022 2 - 2022	1 - 2019 2 - 2020	5 - 2020 6 - 2019	not retired	3 - 2022 4 - 2023	5 - 2019 6 - 2019	5 - 2030 6 - 2025	7 - 2021 8 - 2023
S1S2B No EE	1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025	6 - 2020	not retired	3 - 2024 4 - 2021	5 - 2019 6 - 2019	6 - 2025	7 - 2025 8 - 2022
S1S2B Low EE	1 - 2027 2 - 2027	1 - 2020 2 - 2021	1 - 2025	5 - 2020 6 - 2019	not retired	3 - 2021 4 - 2023	5 - 2019 6 - 2019	not retired	7 - 2022 8 - 2023
S5S1B No EE	1 - 2027 2 - 2027	1 - 2019 2 - 2021	1 - 2025	5 - 2023 6 - 2019	not retired	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2029	7 - 2023 8 - 2022
S5S1B Low EE	1 - 2027 2 - 2027	1 - 2019 2 - 2020	1 - 2025 2 – 2025	5 - 2021 6 - 2020	not retired	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2025	7 - 2022 8 - 2023

Source: PREPA additional responses to Energy Bureau-PREPA ROI 9-1, Table 4, "Retirements All Scenarios", page 13, December 6, 2019.

Table C-7. PREPA Summary of Key Modeling Results – Capacity Retirements (Energy Bureau-PREPA ROI-10-5)

Case ID	AES 1 & 2	Aguirre Steam 1 & 2	Aguirre CC 1 & 2	Costa Sur 5 & 6	EcoEléctrica	Palo Seco 3 & 4	San Juan 5 & 6	San Juan 5 & 6 Conv	San Juan 7 & 8
S4S2B NO EE w/ PPOA	1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 – 2025	5 - 2020 6 - 2020	Retire 2032	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2034	7 - 2023 8 - 2023
S4S2B Low EE w/ PPOA	1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 – 2025	5 - 2020 6 - 2020	Retire 2032	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2025	7 - 2022 8 - 2023
S4S2B Base w/ PPOA	1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 - 2025 2 – 2025	5 - 2020 6 - 2020	Retire 2032	3 - 2023 4 - 2021	5 - 2019 6 - 2019	not retired	7 - 2023 8 - 2022
S4S2B NO EE w/ PPOA, No Solar limits	1 - 2027 2 - 2027	1 - 2020 2 - 2021	1 – 2025	5 - 2020 6 - 2019	Retire 2032	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2025	7 - 2021 8 - 2023
S4S2B Low EE w/ PPOA, No Solar limits	1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 – 2025	5 - 2020 6 - 2020	Retire 2032	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2025	7 - 2022 8 - 2023
S1S2B Low EE w/ PPOA	1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 – 2025	5 - 2020 6 - 2020	Not Retired	3 - 2021 4 - 2023	5 - 2019 6 - 2019	6 - 2034	7 - 2022 8 - 2023
S1S2B NO EE w/ PPOA	1 - 2027 2 - 2027	1 - 2019 2 - 2019	1 – 2025	6 - 2021	Retire 2032	3 - 2023 4 - 2021	5 - 2019 6 - 2019	not retired	7 - 2024 8 - 2021
S3S2B_Base_ w/ PPOA	1 - 2027 2 - 2027	1 - 2023 2 - 2019	1 – 2021 2 – 2019	5 - 2020 6 - 2020	Retire 2032	3 - 2023 4 - 2021	5 - 2019 6 - 2019	5 - 2034 6 - 2025	7 - 2023 8 - 2021
S3S2B NO EE w/ PPOA	1 - 2027 2 - 2027	1 - 2020 2 - 2019	1 – 2019	5 - 2021 6 - 2020	Retire 2032	3 - 2023 4 - 2022	5 - 2019 6 - 2019	5 - 2035 6 - 2025	7 - 2023 8 - 2021
S3S2B Low EE w/ PPOA	1 - 2027 2 - 2027	1 - 2020 2 - 2022	1 – 2019 2 – 2021	5 - 2020 6 - 2019	Retire 2032	3 - 2022 4 - 2023	5 - 2019 6 - 2019	5 - 2035 6 - 2025	7 - 2021 8 - 2023
S3S2B Low EE w/ PPOA_no Solar Limits	1 - 2027 2 - 2027	1 - 2020 2 - 2020	1 – 2019 2 – 2021	5 - 2021 6 - 2019	Retire 2032	3 - 2023 4 - 2021	5 - 2019 6 - 2019	5 - 2034 6 - 2025	7 - 2022 8 - 2021
S3S2B NO EE w/ PPOA no Solar Limits	1 - 2027 2 - 2027	1 - 2020 2 - 2019	1 – 2019	5 - 2021 6 - 2020	Retire 2032	3 - 2023 4 - 2021	5 - 2019 6 - 2019	5 - 2034 6 - 2025	7 - 2022 8 - 2021
S5S1B Low EE w PPOA	1 - 2027 2 - 2027	1 - 2020 2 - 2019	1 – 2029 2 – 2025	5 - 2033 6 - 2020	Retire 2032	3 - 2019 4 - 2019	5 - 2019 6 - 2019	6 - 2025	7 - 2019 8 - 2019
S5S1B No EE w PPOA	1 - 2027 2 - 2027	1 - 2024 2 - 2019	1 – 2034 2 – 2028	5 - 2022 6 - 2020	Retire 2032	3 - 2019 4 - 2019	5 - 2019 6 - 2019	5 - 2028 6 - 2025	7 - 2019 8 - 2019

Source: PREPA response to Energy Bureau-PREPA ROI 10-5, Table 4, "Retirements All Scenarios", page 12, January 22, 2020.

Appendix D. ABBREVIATIONS

AC… air conditioning

AEO… Annual Energy Outlook

AOGP… Aguirre offshore gas port

ATB… annual technology baseline

bcf… billion cubic feet

BESS… battery energy storage systems

CAIDI… Customer Average Interruption Duration Index

CAGR… compound annual growth rate

CC…combined cycle

CCGT… combined cycle gas turbine

CDD… cooling degree days

CHP…combined heat and power

CIAPR… Colegio de Ingenieros y Agrimensores de Puerto Rico

COR3…Central Office for Recovery, Reconstruction, and Resiliency

CSMPR…Cooperativa de Seguros Múltiples de Puerto Rico

CUD…Centro Unido de Detallistas

DG…distributed generation

DER…distributed energy resources

DoD…Department of Defense

DSM…demand-side management

EDF…Environmental Defense Fund

EE…energy efficiency

EIA… Energy Information Administration

Energy Bureau…Energy Bureau of the Puerto Rico Public Service Regulatory Board

ENS… energy not served

EPA…Environmental Protection Agency

EPC… engineering, procurement, and construction

ESM… Energy System Modernization

EV…electric vehicle

FEMA…Federal Emergency Management Agency

FOMB…Financial Oversight and Management Board

FSRU… floating ship regasification unit

GIS…gas-insulated substations

GNP… gross national product

GPCM®… RBAC Incorporated's Gas Pipeline Competition Model

GT…gas turbine

GWh...gigawatt-hour

HAPs… Hazardous Air Pollutants

ICE…interruption cost estimate

ICPO… Independent Consumer Protection Office

ICSE-PR…el Instituto de Competitividad y Sostenibilidad Económica de Puerto Rico

ITC… Investment Tax Credit

IRP…integrated resource plan

kW…kilowatt

kWh…kilowatt-hour

LCOE… levelized cost of energy

LED… light-emitting diode

LEOs…local environmental organizations

LNG… liquified natural gas or propane

LPG… liquified petroleum gas

LTCE…long-term capacity expansion

MATS… Mercury and Air Toxics Standard

MIDA…Industria y Distribución de Alimentos

MMBtu…million British Thermal Units

MMtpa… million metric tons per annum

MTRs… minimum technical requirements

MW…megawatt

MWh…megawatt-hour

NEGOCIADO DE ENERGÍA DE PUERTO RICO
NEPR
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

NAAQS… National Ambient Air Quality Standards

NFPs… not-for-profit intervenors

NOAA… National Oceanic Atmospheric Administration

NPDES…National Pollutant Discharge Elimination System

NPV…net present value

NPVRR…net present value of revenue requirements

NREL… National Renewable Energy Laboratory

NYSERDA… New York State Energy Research and Development Authority

O&M… operations and maintenance

OIPC…Independent Consumer Protection Office

P3…public-private partnerships

PRM… planning reserve margin

PRMA…Puerto Rico Manufactures Association

PROMESA… Puerto Rico Oversight, Management, and Economic Stability Act

PPOAs… power purchase and operating agreements

PREB…Puerto Rico Energy Bureau

PREPA… Puerto Rico Electric Power Authority

PV…photovoltaics

RECs… renewable energy credits

RFP…request for proposals

RFQ…request for qualifications

RICE…reciprocating internal combustion engine

RMI…Rocky Mountain Institute

ROI… Requirement of Information (when issued by the Energy Bureau); Request for Information (when requested by an Intervenor)

RPS…renewable portfolio standard

RSA…restructuring support agreement

SAIDI…System Average Interruption Duration Index

SAIFI…System Average Interruption Frequency Index

SESA-PR… Solar and Energy Storage Association of Puerto Rico

SNG… synthetic natural gas

SO2….sulfur dioxide

STEO… short-term energy outlook

T&D…transmission and distribution

TPA…third-party administrator

TRG...techno-resource group

UPA…Unidos Por Utuado

VOLL…value of lost load

VPP… virtual power plant

WTI… West Texas Intermediate